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## PROGNOSIS AND TREATMENT OF GIANT-CELL SARCOMA<sup>1</sup>

BASED ON A FURTHER STUDY OF END RESULTS IN SIXTY-NINE CASES

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IN NOVEMBER, 1923, before the New York Surgical Society, I read a paper on *Prognosis in Giant-cell Sarcoma of the Long Bones Based Upon the End Results in a Series of Fifty Cases*;<sup>2</sup> and the present paper includes a careful follow-up of these cases as well as a report of nineteen additional cases since observed. The entire series should furnish sufficient data from which to form some definite conclusions on two important, and at present unsettled, points; namely: (1) whether giant-cell sarcoma is always a benign lesion, and (2) what is the best method of treating these cases.

In my earlier paper on the subject I took issue with Bloodgood and, perhaps, with the majority of pathologists, on the assumption that giant-cell sarcoma of the long bones is always benign and never gives rise to metastases. A further clinical and pathological study of additional cases personally observed, as well as those reported in literature, serves to strengthen the opinion which I have already expressed,



FIG. 1.—Giant-cell sarcoma of fibula treated with X-rays alone by Doctor Herendeen. Patient well four years later.

<sup>1</sup> Read before the New York Surgical Society, March 9, 1927.

<sup>2</sup> ANNALS OF SURGERY, March and April, 1924.

that, while the majority of giant-cell sarcomas are benign or at least only locally malignant, there is a certain number of cases which, while possessing the clinical, röntgenological and pathological features of benign giant-cell sarcoma—and are so classed by competent pathologists—do, nevertheless, give rise to metastases and generalization of the disease, thus proving that the diagnosis of benign tumor was incorrect. Moreover, I believe that in the early stages of the disease, it is impossible always to differentiate the malignant from the benign type. In my earlier paper, already referred to, in

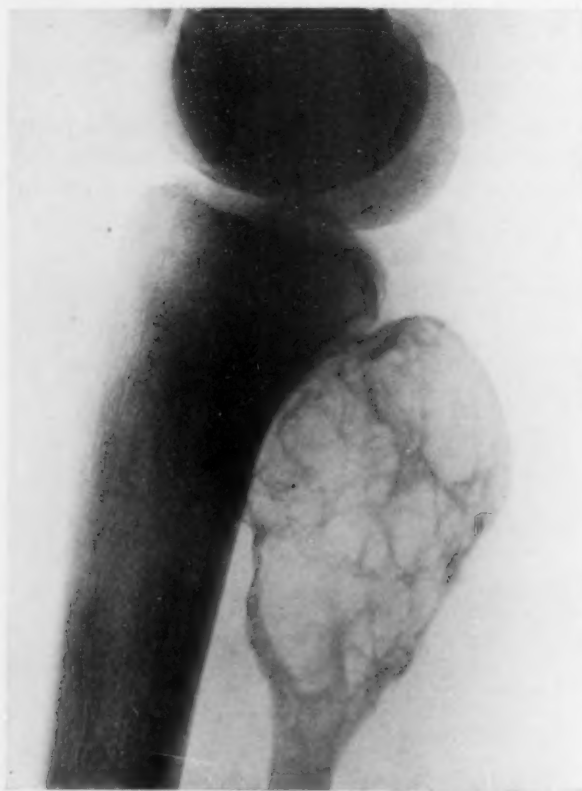


FIG. 2.—Preceding case, one year after treatment was begun.

fifty cases of giant-cell sarcoma of the long bones in which the diagnosis was made by competent pathologists, in no less than ten cases the patient died of metastases. It is only fair to state that a number of these cases were observed many years ago when the pathology of these tumors was less clearly understood.

Since the publication of my paper, the malignant nature of some of these cases of giant-cell sarcoma has been pointed out by other surgeons. McWhorter and MacGuire,<sup>3</sup> in a series of twenty cases (collected from the records of New York, Presbyterian and Bellevue Hospitals), diagnosed as giant-cell sarcoma, found four to be malignant, the proportion being identical to that found in my own series. Finch and Gleave<sup>4</sup> report a case of typical, benign, giant-cell sarcoma of the femur—the diagnosis being based on the clinical, Röntgen-ray and pathological evidence—which later developed pulmonary metastases. Fortunately, in this case an autopsy was secured, thus permitting a study of the microscopic section of tumor of the lung. A full report of this case follows:

*A Case of Osteoclastoma (Myeloid Sarcoma, Benign Giant-cell Tumor) with Pulmonary Metastasis.*—E. F. FINCH and H. H. GLEAVE report the following case from the Department of Pathology of the University of Sheffield:

<sup>3</sup> Archives of Surgery, vol. ix, p. 545, November, 1924.

<sup>4</sup> The Journal of Pathology and Bacteriology, vol. xxix, 1926.



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W. B., aged forty-nine, was admitted to the Royal Infirmary, Sheffield, on March 17, 1917, with a fracture of the lower third of the right femur, the result of slipping on ice. Good apposition of the fragments could not be obtained by manipulation, and a week later the site of the fracture was explored. It was found then that the bone was so softened that a nail could be pushed into it by simply pressure of the fingers. A diagnosis of osteitis deformans was made, and after manipulation of the fragments into a better position the wound was closed, no foreign body having been left in the bone. The fracture healed, no further skiagrams being taken owing to the stress of work.

His leg gave him no further trouble for eighteen months. He then had pain at the site of the old fracture and noticed swelling in the region of the right knee-joint. He was then sent by his doctor for a course of massage to the Edgar Allen Institute; this is an institute for remedial exercises and massage in Sheffield.

In February, 1921, he returned to the Royal Infirmary with a swelling of the lower end of the right femur. The report of the skiagram by Dr. Rupert Hallam was "myeloid sarcoma". The skiagrams taken at the time of the accident in 1917 were then reexamined and found to show definite evidence of a medullary tumor at the site of fracture. On further interrogation the patient gave the history that he had had "rheumatism" in the right knee-joint in 1915 and had damaged the "ligaments" in 1916. The condition of things was explained to him; no treatment could be suggested except amputation. It was pointed out to him that local removal of the tumor would leave the bone so thin that fracture would be inevitable. He was advised to carry on with the aid of a caliper splint until the inevitable spontaneous fracture occurred; amputation would then be done. In the meantime he could continue with his work. It was explained to him that the tumor was not malignant. He fully appreciated the fact that he could earn more with two legs than after amputation. His case was followed up and he reported from time to time that everything was satisfactory.

He commenced with pain in the leg again in December, 1924, and on January 18, 1925, he was again admitted to the Royal Infirmary with a spontaneous fracture of the right femur. The leg was amputated through the middle of the thigh on January 21, 1925, well above the tumor. The wound healed normally and an artificial limb was provided. The pathologist's report of the tumor was "myeloid sarcoma".



FIG. 3.—Preceding case, four years after treatment was begun.

On October 2, 1925, the patient was readmitted. For some days he had had great pain in the stump, which was swollen, red, œdematous and extremely tender. The diagnosis was made of abscess formation, due to hitherto latent sepsis in the bone. He was operated upon the same afternoon with a big incision. When, however, sinus forceps were pushed into the mass, there was no pus; only blood clot and growth were evacuated. The next day the patient was spitting blood-stained sputum. He stated that he had been

doing this since July, 1925. His lungs were examined by X-rays and Doctor Hallam reported "typical secondary deposits of new growth present in both lungs". In view of this no operative interference with the stump was advised. He became wasted and cachectic and on January 28 he had a severe hemorrhage from the stump and the femoral artery was tied. He died on January 30, 1926.

*Clinical Comment.*—The case has points of great clinical interest. When first admitted in 1917 the history did not suggest a spontaneous fracture. The presence of myeloid sarcoma was not diagnosed either by the skiagram or even at operation. A portion of the soft bone should have then been removed for examination and the diagnosis would then have been probably made earlier. The treatment then advised would have been amputation as union of the femur in the presence of myeloid sarcoma would be so uncertain and unsatisfactory. Stress of



FIG. 4.—Giant-cell sarcoma of lower end of femur, treated primarily by operation. The tumor promptly recurred and was treated with X-ray. Patient well at present, two years later; walks with limp.

work owing to the war must be made the excuse for the mistake in diagnosis by omission of further skiagrams, etc.

No foreign body was inserted at the operation because of the diagnosis of osteitis deformans. No one was more surprised than the surgeon in charge of the case (E. F.) when union occurred.

It was only in February, 1921, when the clinical appearance was obviously that of a medullary tumor of the lower end of the femur, that the skiagrams of March, 1917, were reëxamined. It could be then clearly seen that the growth was already present four years previously. He was not urged to submit to amputation on account of the subsequent disability. He had had the growth at least four years; it was doing no harm except increasing in size. The size was such in 1921 that amputation was the only course available. The tumor was obviously benign in the clinical sense. Why not

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wait for the inevitable fracture and then amputate? This occurred in January, 1925. Amputation was performed and the case apparently in the clinical sense was finished. Not at all; the tumor metastasized and produced death on January 30, 1926. From which history we may learn that (1) a fracture at the site of a myeloid sarcoma may heal soundly; (2) it is not safe to trust to the benignancy of this tumor.

One of the writers (E. F.) has watched another case of myeloid sarcoma develop for four years until the inevitable spontaneous fracture occurred, necessitating amputation, but he is quite sure he will never watch another.

*Histology.—Deposits in Lungs.*—The histological appearance varies considerably in different areas. The tumor tissue is chiefly composed of interlacing bundles of spindle-shaped fibrous tissue cells forming intercellular collagen. Areas of well-formed fibrous tissue are numerous throughout the tumor. As compared with the spindle-celled areas of the primary growth, the cells here are more closely packed and have larger, more active looking nuclei. In the more cellular areas giant cells of malignant type are common and occasionally multipolar mitoses are seen. The general appearance here is that of a fibrosarcoma.

While in some fields this spindle-celled tissue alone is seen, in the majority of the sections a striking feature is the presence of giant cells of osteoclast type. These cannot be distinguished in their general aspect or nuclear characteristics from the giant cells of the primary growth. In many areas they are collected together in large numbers and form the predominant feature of the section.

This case may be summarized as follows:

1. A case of osteoclastoma (myeloid sarcoma) of the lower end of the femur is reported, of at least nine years' duration, in which metastasis to the lungs has taken place.
2. The metastases have the histological characters of the primary tumor, with numerous typical giant cells and in addition an admixture of fibrosarcomatous tissue.
3. This case, and other cases from the literature to which we refer, confirm the neoplastic character of these tumors, and leave no doubt that, though usually slow-growing and only of local malignancy, they are essentially sarcomatous.



FIG. 5.—Preceding case, two years after treatment with X-ray by Doctor Herendeen.

GOFORTH, of Philadelphia (*Archives of Surgery*, December, 1926), has published another case of malignant giant-cell tumor with lung metastasis, a brief report of which is as follows: A male patient, aged thirty-four years, struck his left knee against a chair in 1916; pain and slight swelling followed. A few months later he entered the Polyclinic Hospital (service of Doctor Cooperman and Doctor Case), where a diagnosis of giant-cell tumor was made. In 1917, or one year after the injury, a thorough curettage was done. The tumor recurred and was again curetted in 1919. A second recurrence developed, and the patient was again admitted to the hospital, at this time complain-



FIG. 6.—(Case No.) Giant-cell sarcoma (clinical and röntgenological diagnosis) treated with X-rays in 1925. Patient developed metastasis to the jaw two years later. (Memorial Hosp. Case.)<sup>\*</sup>

ing of inability to use the left leg and frequent attacks of sharp, needle-like pains throughout the knee. He had had to use braces and crutches for the preceding ten months. Physical examination revealed an irregularly enlarged knee, twice the size of the normal knee, which was tense and tender, and quite hard in some areas. There was complete loss of function. The routine laboratory tests were negative. A röntgenogram showed a bone destroying neoplasm involving the upper part and head of the left tibia, the head of the fibula, and the posterior portion of the internal condyle of the femur. In October, 1921, the leg was amputated well above the knee. In August, 1922, the patient again returned to the hospital complaining of cough and substernal pain on coughing. He had been spitting up blood for the last five months, had lost much weight, and had

grown progressively weaker. A röntgenogram of the chest revealed definite evidence of lung metastasis. The patient failed rapidly and died in November, 1922. In regard to the pathological examination, Goforth says: "Tissues from the first and second curettements unfortunately were not available for this study, but were reported as showing the structure of typical giant-cell tumor. Dissection of the tumor in the amputated leg revealed a destructive, soft cellular, invasive sarcomatous growth involving all the bones and soft tissue about the knee-joint.

"Sections taken from different portions of the neoplasm showed many areas composed of closely packed, thick, spindle-shaped cells, scattered through which were numerous large, multinucleated giant cells of the epulis type. Very little fibrous supporting

<sup>\*</sup>This case is selected from the Memorial Hospital cases by Kolodny, in his study of the Bone Registry cases as a "Typical Benign Giant-cell Tumor." It well illustrates the impossibility of making a correct diagnosis of giant-cell sarcoma, from clinical and X-ray data alone.

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tissue was present. Other areas consisted almost exclusively of spindle cells, relatively constant in size and staining reaction but showing numerous karyokinetic figures, suggestive of rapid growth. Still other areas consisted of closely packed, varying sized, deeply staining, rounded or polyhedral cells, scattered through which were many irregular giant-cells, not of the epulis type, containing varying amounts of cytoplasm, and from one to four or five large, deeply staining oval nuclei, many of which were dividing. No areas of calcification or ossification were demonstrable. Dr. E. A. Case of the Polyclinic Hospital described the condition as 'giant-cell sarcoma with a number of areas of actively growing cells' and our study of the various sections suggested that basically the tumor was a true giant-cell tumor, which now showed malignant transformation, an opinion in which Dr. James Ewing concurred."

This case Goforth regards as both atypical and unusual. Briefly, "the tumor followed injury; was treated by curettement after a year; recurred and was treated again by curettement two years later; recurred a second time with the aspects of malignancy and was treated by amputation five years after and caused death by metastasis, proved röntgenologically, six and one-half years after the appearance of the original growth; so it would seem that we are dealing with a true giant-cell tumor that had undergone malignant transformation."

Among the conclusions reached by Goforth are the following:

1. The known behavior of the giant-cell tumor warrants its being classified as a true neoplasm.
2. The giant-cell tumors constitute a series. Those at the lower end of the scale possess relatively adult fibrous stromas and are essentially benign. They exhibit more cellular, and active stromas, composed chiefly of relatively immature fibroblastic cells and become increasingly more locally aggressive as the scale is ascended.
3. Under the stimulus of inadequate or improper treatment, they may recur locally, those at the upper end of the scale being especially liable to this tendency. Such recurrences, as a rule, are more aggressive or virulent than the primary growth, both clinically and microscopically.
4. They are potentially malignant and may as a result of repeated or improper treatment excitation on rare occasions undergo malignant transformation and metastasize.

The last two reports are most convincing as they include not only complete clinical and Röntgen-ray evidence but a microscopical study of the primary and metastatic tumors as well.

The differential diagnosis of giant-cell sarcoma of the long bones has

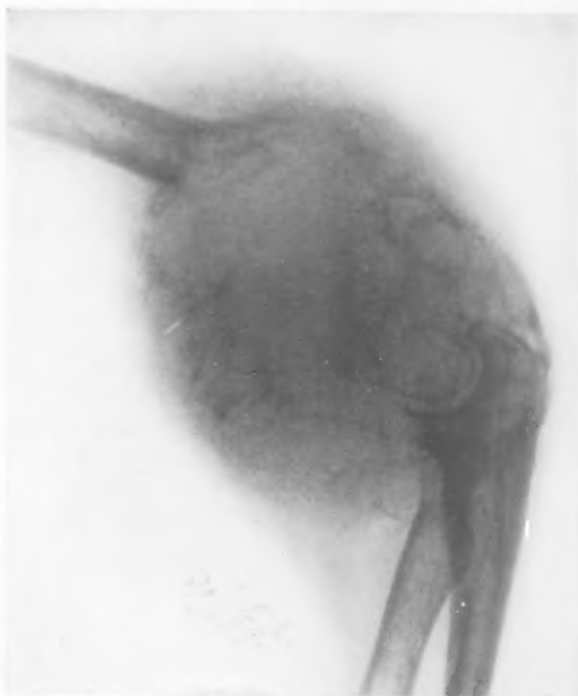


FIG. 7.—Preceding case, in October, 1925, seven months after treatment was begun by Doctor Herendeen.



already been discussed in my previous paper so that it will be unnecessary to review it here. The principal object of the present paper is to discuss more fully the best methods of treating giant-cell sarcoma of the long bones. I feel that there is great need of such discussion for the reason that there seems to be much doubt in the minds of most surgeons as to what is the proper method of procedure to employ in these cases.

*Biopsy.*—The first question that arises is, shall a biopsy be performed before any method of treatment is adopted? Upon this point there is the



FIG. 8.—Preceding case, September, 1926, marked local improvement but shortly after developed metastases of the jaw.

widest variance of opinion. I believe there is a growing tendency to forego biopsy and to trust to a clinical and Röntgen-ray diagnosis in tumors of the long bones, particularly of the supposedly benign giant-cell type. The reason for this, I believe, is due to the fact that there is a very definite but, in my opinion, exaggerated fear that exploratory operation is attended with considerable risk, such as, an ensuing and slowly healing sinus which is liable to become infected, and furthermore, that there is danger of producing gen-

eralization of the disease if the tumor proves to be malignant. As stated before, I believe that these dangers have been greatly over-estimated. At the same time, biopsy or exploratory operation in giant-cell sarcoma should never be performed merely for the sake of securing a piece of tissue for microscopic study; but should consist of as complete curettage as possible, down to healthy bone followed by an application of zinc chloride or carbohc acid to the cavity. In other words, the exploratory operation should be a very important part of the treatment itself. To simply cut into a giant-cell sarcoma without thoroughly curetting down to the bone, is to court disaster. In the first place, hemorrhage is produced which it is difficult to control; and in the second place, infection is far more likely to occur than if complete curettage had been performed.

*Curettage.*—Curettage for central tumors of the long bones has been widely

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employed by continental surgeons, but more generally so by American surgeons since Bloodgood has shown that curettage followed by the use of carbolic acid or zinc chloride has resulted in a very large proportion of cures (80 per cent.). Curettage is not the simple operation it is generally believed to be, especially if the tumor is of considerable size. It should not be undertaken lightly by the surgeon who has had little experience with these conditions nor by any other than the one who is to have final charge of the patient. One of the dangers to be guarded against is that of hemorrhage. These tumors are extremely vascular, and fatal hemorrhages have resulted from a simple curettage. Hence, the operation should always be performed under a rubber tube tourniquet, and



FIG. 9.—May, 1923. Giant-cell sarcoma of upper end of humerus following recent fracture. Treated with toxins for five months, then one radium treatment. Tumor steadily increased in size until November, 1923, when it began to gradually decrease. Patient in good health four years later. Arm useless from musculo-spiral paralysis.



FIG. 10.—Preceding case, September, 1923.

should always be as complete as possible, that is, it should extend down to hard, healthy bone, thus lessening the chances of a recurrence as well.

*Treatment of Cavity.*  
—Surgeons at present are divided in opinion as to the treatment of the bony cavity left after curettage. The older method advocated by Bloodgood and still very generally employed, that is, packing the wound with gauze, has very definite disadvantages. The principal ones are: (1) the danger of subse-

quent infection, which, many writers state, is sure to occur; and (2) the danger of sinus formation, which sinus may persist for a very long

time. For these reasons, many surgeons have abandoned gauze packing and have attempted to close the wound entirely, hoping to get primary wound healing. A number have attempted to fill the cavity at the time of operation with various substances, *e.g.*, fragments of bone, fat or muscle grafts. Owing to the free bleeding that almost always occurs, such grafts seldom survive; and they may favor the production of the infection or sinus-formation which they are supposed to prevent. Some surgeons have used bismuth or iodoform paste; but these have proved even more objectionable



FIG. 11.—Preceding case, November, 1923.

and have now been abandoned. One patient who had been treated in this way, later came under my care. The sinus had become infected and I had to perform another curettage to get rid of the paste. This was never entirely accomplished. The sinus persisted for more than a year when it became re-infected and a secondary amputation had to be performed. No evidence of the tumor was found. The patient died some months later of nephritis.

My own results show that since the introduction of Dakin's solution, it is possible in practically all cases to prevent infection, even if the cavity is packed with gauze. Gauze packing is the only method that permits the complete control of hemorrhage in the advanced and very vascular cases. I had one case, an extensive sarcoma involving the knee-joint as well as the upper end of the tibia, in which a very large cavity was left after curettage, and the hemorrhage could not have been controlled in any other way than by gauze packing. Of course the limb was supported by a plaster cast which was applied from the foot to the pelvis. The packing was removed as soon as possible, two or three days later, and the wound was kept clean with Dakin's solution. The cavity filled rapidly by healthy granulations and the sinus had completely healed in three and one-half months (prophylactic toxin treatment was begun a few days after the operation and one radium treatment was given at the end of three months). Here we have a striking example of Nature's success in dealing with extensive bone destruction. Röntgenograms taken five years later

I have never used any of these methods nor do I believe them necessary.

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showed complete restoration of the condyles as well as the destroyed area of the tibia, and there was perfect functional result. This patient remained well for eight years and then died of hemorrhages from child birth. If we can deal successfully with such extensive cases as this without resorting to resection and bone grafts, then we ought to be able to manage the simple and less advanced cases.

When dealing with smaller cavities, the gauze packing may be removed in twenty-four or forty-eight hours, thereby lessening the danger of infection. It should be remembered that most of the cases of severe infection that have been emphasized by Ewing and others, occurred before the days of Dakin's solution. I had two cases in my own series, in which I was obliged to amputate on account of very severe infection; but these were the only ones in a large number of cases. I have had only one since I began using Dakin's solution, and this followed the introduction of bismuth paste by another surgeon, and was further aggravated by the injudicious use of radium in the presence of an already existing infection.



FIG. 12.—Preceding case, December, 1924.

In certain cases, especially in those of the pelvic bones, I strongly advise against curettage or operation of any kind inasmuch as experience has shown that in these cases the cavity often fails to heal and becomes more easily infected than in the long bone cases, often resulting in a foul, fungating tumor which adds greatly to the patient's discomfort and hastens his death. I have seen three such cases, yet it is only fair to state that these were all malignant osteogenic sarcomas. I do not believe that the diagnosis of giant-cell sarcoma of the pelvic bones can be made with any degree of certainty; and therefore, in all cases of tumor of this region I advise radiation combined with systemic injections of the mixed toxins of erysipelas and *Bacillus prodigiosus*. Prac-

tically all these cases have reached the inoperable stage when first observed. Benign giant-cell tumors of these bones are extremely rare.

*Toxins.*—In addition to curettage, and carbolic acid or zinc chloride applied to the cavity, I believe that the administration of injections of the mixed toxins of erysipelas and *Bacillus prodigiosus* for a period of three or four months after operation greatly lessens the chances of a recurrence of the disease, by destroying whatever cells have been left behind. When used as a prophylactic measure, only small doses of the toxins are given, just enough

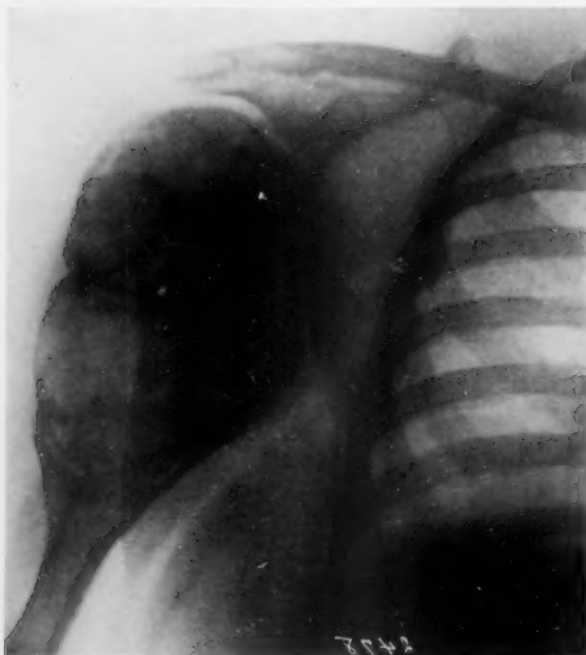


FIG. 13.—Preceding case, August, 1926.

to produce mild reactions, and thus the treatment interferes but little with the patient's ordinary routine of life. If it is possible to eradicate extensive tumors and to effect a permanent cure by the use of the toxins alone, without curettage, as our series of cases proves, then there is certainly strong theoretical grounds for using the method as a routine measure after operation. The end-results in the cases thus treated support this view.

*Radiation.*—There is, I believe, an increasing tendency on the part of surgeons to turn over all cases of bone sarcoma, especially giant-cell sarcoma, to the radiologist. The surgeon is led to believe that most cases of giant-cell sarcoma can be cured by radiation without surgery of any kind; and furthermore, that a correct diagnosis can be made from the röntgenograms alone, without biopsy, in practically every case.

In a recent and valuable contribution to the subject of *Malignant Disease of the Bones*, Nové, Josserand and Tavernier of Lyon, France, state that the present data available in France are insufficient to permit any definite conclusions as to the value of radiation in giant-cell sarcoma. They state that, strangely enough, Regaud, Director of the Radium Institute of Paris, has had no experience with radiation in giant-cell tumors of the long bones, although, he has successfully treated three cases of epulis of the jaw. The authors mentioned have observed one case of giant-cell tumor of the ulna treated by radiation after curettage and ulceration, without effect, amputation later being



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necessary. Their conclusions on the subject are as follows: "It seems, on the whole that 'tumeur myeloplaxes' (giant-cell tumors) are but slightly radio sensitive . . . We have no radiographs followed for a long time, to show what happens to the bony cavity after a cure."

Up to the present time twenty-nine cases of giant-cell sarcoma of the long bones have been treated by radiation at the Memorial Hospital and the results obtained in this series, I believe, enable us to answer in the affirmative the mooted question as to whether or not it is possible to cure giant-cell sarcoma by this method of treatment. This series includes five cases (one treated by radium and four by Röntgen-ray) in which the tumor was apparently completely controlled, and the normal function of the limb was restored. While these results prove that it is possible to cure giant-cell sarcoma by radiation alone or following curettage, the number of cases so treated is too small and the period of observation is too short—compared with the series treated by surgery alone or by surgery and toxins—to permit the conclusion that radiation should be the method of choice.

There are certain disadvantages associated with radiation as the *primary* method of treatment. The first in matter of importance is the difficulty, and in some cases, the impossibility, of making a positive diagnosis of benign giant-cell tumor from the clinical and Röntgen-ray evidence. Our series shows that this error in diagnosis, that is, the inability to tell whether the tumor is benign or malignant, occurs so frequently (in one out of five cases) that it cannot be ignored. Our series contains four cases that were treated as benign giant-cell tumors, the diagnosis being based on the clinical and Röntgen-ray evidence, which later proved to be malignant tumors. Hence, the importance of a histological examination in these cases.

Another distinct disadvantage is the long duration of treatment, often extending over a period of one or two years, and thus entailing prolonged disability. This, in the case of a working man or woman, is a consideration of great importance. The period of disability in cases treated by surgery, or surgery and toxins or by toxins alone, has been found to be much shorter.

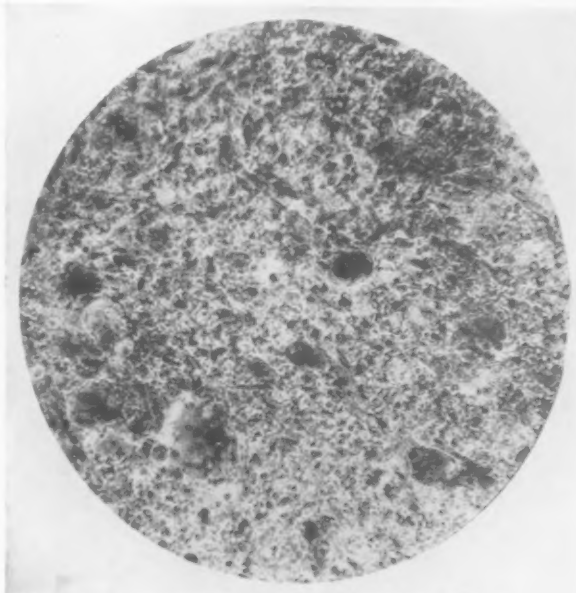


FIG. 14.—Microphotograph of preceding case.

The results obtained by a combination of curettage and radiation have not been entirely satisfactory. As Nové, Josserand and Tavernier have stated, the use of radium after curettage increases the chances of infection. The case of Bancroft,<sup>6</sup> referred to in my previous paper on the subject,<sup>7</sup> illustrates the unsatisfactory results that sometimes follow this combination. In two of my own cases of giant-cell sarcoma involving one condyle of the femur, I used radium and Röntgen-ray following thorough curettage. In one case



FIG. 15.—Giant-cell sarcoma of lower end of femur, treated with X-rays alone. Patient in good health with excellent functional result, three and one-half years later.

a fracture occurred two years later in a bone rendered brittle by prolonged radiation (150,000 mc. hours given over a period of one year); and in the other case, a secondary amputation had to be performed two years later for an intractable and most painful ulcer caused by over-radiation. In both or in all of these cases, it must be conceded that the unfortunate results were due to over-radiation or an injudicious application of a method, rather than to the method itself; and we have hoped that the poor or indifferent results obtained in the earlier treatment of sarcoma of the bone, with increased knowledge of technic,

might give place to far better results. However, up to the present time, our results, while highly interesting and most encouraging, especially the results obtained by Doctor Herendeen with the Röntgen-ray, are not in my opinion equal to the results obtained by surgery alone; and they are distinctly inferior to those obtained by a combination of surgery and toxins.

We believe that it is impossible at present to state definitely which form of radiation, that is, radium, high-voltage or low-voltage Röntgen-ray, gives the best results. A study of the individual cases treated at the Memorial Hospital shows apparent cures resulting from the use of any one of these methods.

<sup>6</sup> Clinics of North America, December, 1921, p. 1747.

<sup>7</sup> ANNALS OF SURGERY, March and April, 1924.

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At present the majority of cases of giant-cell sarcoma at the Memorial Hospital are being treated by Doctor Herendeen with high-voltage Röntgen-ray.

One of the most interesting cases of our entire series, in the opinion of Bloodgood, is worthy of note.

This patient, a female, aged fifty-five years, fell and injured her shoulder in February, 1923, producing a spiral fracture. A few weeks later a tumor developed. The patient came under my observation in May, 1923. At this time examination showed a large tumor pressing on the musculo-spiral nerve causing complete wrist-drop. A biopsy was performed revealing a giant-cell sarcoma. This was pronounced a benign tumor by both Bloodgood and Ewing. The patient was given injections of the mixed toxins for six weeks, at the end of which time, one radium-pack treatment (12,000 mc. hours) was applied over three areas at a distance of 6 cm. She then returned home where the toxin treatment was continued for several months by her family physician, Dr. J. H. Reid, of Troy, N. Y. I examined her in September, and found a huge tumor extending out over the pectoral region nearly to the sternum, and backwards over the scapula. I regarded it in spite of the microscopic diagnosis as, probably, an infiltrating, malignant tumor. The toxin treatment was continued for a few months longer; no further radium was used. Instead of going on to a fatal issue, as I believed certain, the tumor began to decrease slowly in size during the month of November, and continued to do so for a year or more. The patient's general health remained good throughout the entire period. At the present time, four years later, there is a comparatively small, hard mass at the site of the huge tumor, made up, undoubtedly, of regenerated bone which has taken the place of the tumor and the destroyed portion of the humerus. In this case I think we must give the credit of the satisfactory result to both the toxins and radium. If a single dose of radium was responsible for the disappearance of this very large tumor, then we are greatly over-treating our cases in giving repeated doses over a prolonged period of time, that is, many months or years. In the case just cited, in spite of the apparent cure of the disease, the arm is and always will be quite useless on account of the complete musculo-spiral paralysis and ankylosis at the shoulder joint; and undoubtedly the patient would have been better off had an early amputation been performed. Note: When my former paper went to press, I regarded the patient's condition as hopeless.



FIG. 16.—Preceding case, three and one-fourth years later.

*Method of Choice.*—My personal opinion based upon the data thus far available is, that the method of choice in the treatment of giant-cell sarcoma or giant-cell tumor presumably of the benign type, is surgery (thorough curettage followed by carbolicization) combined with prophylactic toxin treatment. In some cases, especially in the very extensive ones, it may be advisable to give in addition, a single radium-pack treatment but in a very moderate dose as prolonged radiation after curettage interferes with the normal and rapid

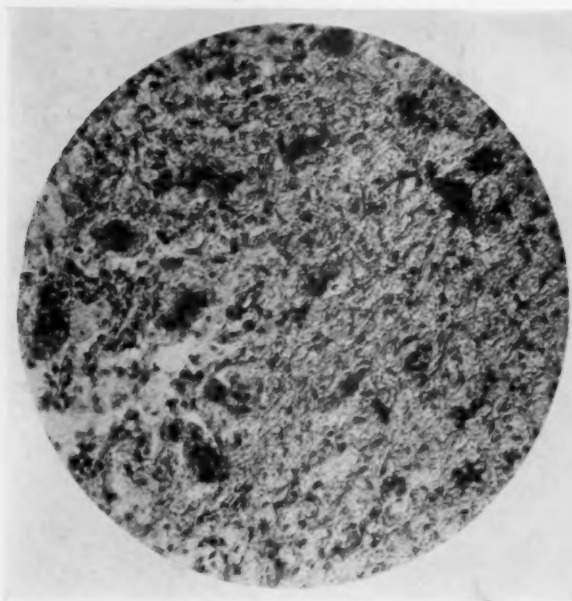


FIG. 17.—Preceding case.

healing of the wound and filling up of the cavity with healthy granulation tissue, and furthermore, it predisposes to infection.

A brief synopsis of our entire series of sixty-nine cases treated by various methods, follows:<sup>8</sup>

#### GROUP I

*Cases Treated Primarily with X-rays or Radium without Previous Biopsy*

1. E. Giant-cell sarcoma or cyst of upper end of humerus (clinical and röntgenological diagnosis) treated by X-rays. Patient well at present, five years.
2. M. Giant-cell sarcoma of lower end of femur (clinical and röntgenological diagnosis) treated with radium alone, 90,000 mc. hours, over a period of one year. Patient well with normal function five years later.
3. G. Giant-cell sarcoma of lower end of radius treated with X-rays alone over a period of two and one-half years. Patient well four years later.
4. G. Giant-cell sarcoma of upper end of tibia (clinical and röntgenological diagnosis) treated with X-rays alone over a period of two years. A pathologic fracture occurred. Amputation was performed. Microscopical diagnosis by Doctor Ewing: probably telangiectatic central sarcoma of mild malignancy (?) Toxin treatment given after amputation. Patient alive two years later but in very poor health.
5. F. Giant-cell sarcoma of upper third of fibula (clinical and röntgenological diagnosis) treated with X-rays alone. Tumor much reduced in size. Patient well five years later.
6. H. Giant-cell sarcoma of upper end of femur (clinical and röntgenological diagnosis) treated with X-rays for one year. The tumor steadily increased in size and curettage was performed, revealing very vascular broken-down tumor tissue which resembled giant-cell tumor. The patient grew worse steadily. The tumor extended to ileum. Death occurred in one and one-half years. No evidence of metastases. Histological diagnosis uncertain, due to broken-down condition of tissue removed. Degenerating chondroma (?).

<sup>8</sup> A fuller history of many of these cases can be found in *ANNALS OF SURGERY*, March and April, 1924.

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7. U. Tumor of upper end of ulna, diagnosed as giant-cell sarcoma benign, treated with X-rays for a period of one and one-half years, when metastasis developed to the jaw. This case is reported in Kolodny's review of the Bone Sarcoma Registry as a "typical benign giant-cell tumor." (April No. *Surgery, Gynecology, and Obstetrics*, 1927.)

8. H. Benign giant-cell tumor of lower end of tibia (clinical and röntgenological diagnosis) treated with X-rays alone for a period of four months. The tumor continued to increase in size rapidly, pulmonary metastasis developed, and the patient died in five months. This proved to be a highly malignant osteogenic sarcoma.

9. C. Giant-cell sarcoma of os calcis. Clinical and röntgenological diagnosis was that of benign giant-cell tumor. Patient treated with X-ray alone; well three years later.

10. N. Giant-cell sarcoma of lower end of femur, treated with X-rays alone for a period of eight months. Marked improvement in condition; patient still under treatment. (Case of Doctor Heronstein.)

11. R. Giant-cell sarcoma of radius (clinical and Röntgen-ray diagnosis, treated by Röntgen-ray.

12. H. Giant-cell sarcoma of humerus, treated by Röntgen-ray. Well two years.

13. F. Giant-cell sarcoma of upper end of humerus (clinical and röntgenological diagnosis), treated with X-rays for a period of one and one-half years. Patient well three years later. In this case the clinical evidence was not as definite as in the other cases and I believe that tuberculosis cannot be ruled out.



FIG. 18.—(Case No.) Giant-cell sarcoma of lower end of femur treated with radium (total 98,406 mc. hours). Patient well five years later. (This patient was treated by Doctor Quick.)

## GROUP II

### *Cases Treated by Radiation after Biopsy or Curettage*

1. N. Benign giant-cell sarcoma of tibia (clinical, röntgenological and microscopical diagnosis), treated by curettage and radium; 40 millicuries of bare tubes of radium emanations were placed in the cavity of wound after curettage, and left there for forty-eight hours. Slow filling up of cavity; no signs of infection until eight



months later when there was evidence of a recurrence. A second curettage was performed; infection developed; amputation was performed. Pulmonary metastasis developed and the patient died in four months. Published in full by Ewing and Stone.

2. S. Benign giant-cell sarcoma of upper end of tibia (clinical, röntgenological and microscopical diagnosis. Curettage was performed followed by treatment with radium and X-rays. Amputation was performed followed by recurrence in the stump of thigh and extension of disease into pelvis. Death shortly afterwards; no definite pulmonary metastasis could be determined.

3. H. Benign giant-cell sarcoma of upper end of tibia (microscopical diagnosis), treated by curettage, followed by radium (12,000 mc. hours in form of pack). Patient well four years later.

4. R. Benign giant-cell sarcoma of upper end of tibia. Curettage and microscopical examination. Treated by radium and X-rays for one year (150,000 mc. hours). Patient in good condition for two years when a pathologic fracture occurred following a slight strain; slow healing; stiff knee. Patient alive and well five years later. Stiff knee.

5. B. Benign giant-cell sarcoma of lower end of femur. Curettage and microscopical examination. Treated by radium and X-rays for one and one-half years after amputation. A small, painful, radium ulcer developed above knee, which it was impossible to heal and which required re-amputation. Patient well five years later.

6. M. Benign giant-cell sarcoma of lower end of femur, treated by curettage followed by X-ray treatment. Case reported in full by



FIG. 19.—Preceding case, two and one-half years after treatment was begun.

Bancroft in *Clinics of North America*, December, 1921. Four operations performed; finally resection of lower end of radius and ulna. Patient alive but with considerable impairment of function, seven years later. (This patient was not under my care but seen in consultation only.)

7. S. Benign giant-cell sarcoma of lower end of femur (clinical and röntgenological diagnosis confirmed by biopsy), treated by X-rays. Later tumor increased in size; pathological fracture occurred; amputation was performed on account of useless limb. Microscopical diagnosis; malignant central sarcoma. Patient died of metastases six months later.

8. R. Benign giant-cell sarcoma of lower end of femur; diagnosis confirmed by

## PROGNOSIS AND TREATMENT OF GIANT-CELL SARCOMA

biopsy; no curettage. Treated by X-ray for two years. Patient well with useful leg, three years later.

9. R. Benign giant-cell sarcoma of lower end of femur; diagnosis confirmed by biopsy. Treated by X-rays. Patient well four years later.

10. H. Benign giant-cell sarcoma of lower end of femur; diagnosis confirmed by microscopic examination. Primary treatment consisted of partial resection of condyle. Apparent recurrence developed one and one-half years later. X-ray treatment given for six months. Patient in good health five years after the operation or three and one-half years after the X-ray treatment was given. He is able to get about, with marked limp; has about 45 degrees of motion.

11. K. Benign giant-cell sarcoma of upper end of tibia. Curettage by Dr. Joseph A. Blake in June, 1922. Post-operative treatment at Memorial Hospital; nine treatments from February to May, 1922. Examination in November, 1926, discloses recurrence of pain but no evidence of recurrence (according to roentgenogram); cavity not entirely filled in. Further X-ray treatment ordered. Patient well five years after curettage.

12. B. Benign giant-cell sarcoma of upper end of tibia; curettage. Treated by radium after operation. Case not traced.

13. D. Giant-cell sarcoma of the lower end of the femur; curettage. Microscopical diagnosis by Ewing was that of benign giant-cell tumor. Case not traced.

14. S. Giant-cell sarcoma of femur, treated by curettage and Röntgen-ray, with marked improvement.

15. D. Case of Doctor Quick. Giant-cell sarcoma of femur treated by curettage and bone-graft by Doctor Verdi four years ago. Recurrence. Röntgen-ray diagnosis; giant-cell tumor. Treated by heavy radiation (Röntgen-ray and radium). Patient in good condition one year later.



FIG. 20.—Preceding case, five years after treatment was begun.

### GROUP III

#### *Cases Treated by Surgery Alone (Curettage, Resection or Amputation)*

1. H. Giant-cell sarcoma of radius. Curettage performed by Dr. Russell Hibbs; patient later observed by Doctor Coley. In good health eight years later.

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2. S. Giant-cell sarcoma of tibia. Clinical, X-ray and microscopical diagnosis. Amputation performed. Metastasis to the radius developed. Death occurred one and one-half years later.

3. P. Giant-cell sarcoma of tibia, treated by curettage and carbolic acid. Operation performed by Dr. Royal Whitman. Patient well two years later.

4. McG. Giant-cell sarcoma of tibia. Curettage performed by Doctor Coley in 1898. Case not traced beyond one year.

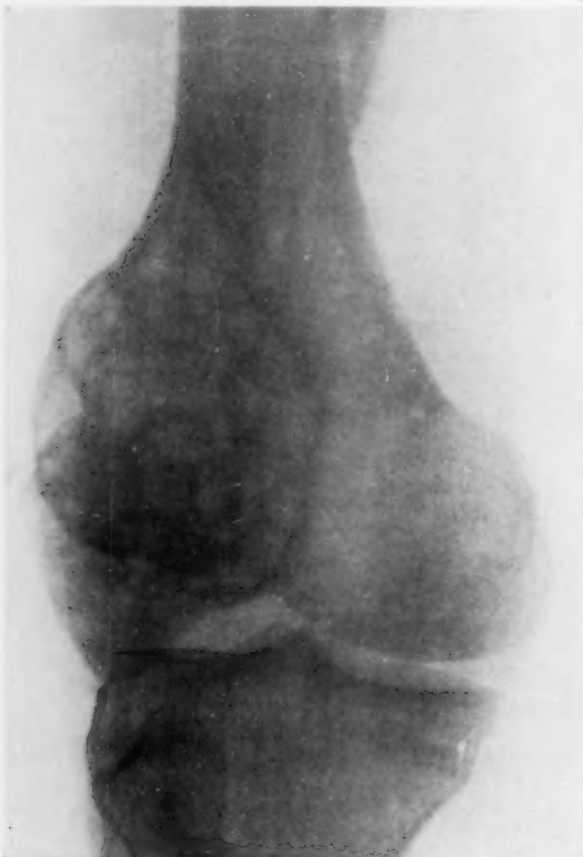


FIG. 21.—December, 1924. Giant-cell sarcoma of femur treated by curettage and radiation. Two years later a fracture of the leg developed following a very slight strain. Patient well at present, with a stiff knee.

5. H. Giant-cell sarcoma of humerus. Amputation performed. Metastases developed shortly afterwards ending in death.

6. W. Giant-cell sarcoma of tibia. Amputation performed. Death from pulmonary metastases seven years later.

7. P. Giant-cell sarcoma of tibia. Amputation performed by Dr. Charles A. Parker, of Chicago. Patient well several years later.

8. S. Giant-cell sarcoma of femur. Curettage performed. Patient in good health two years later when last traced.

9. Giant-cell sarcoma of femur, treated by curettage and carbolic acid, followed by recurrence. Second curettage and muscle implant. Patient well two and one-half years later.

10. F. Giant- and spindle-cell sarcoma of humerus (giant-cells of epulis type). Death from metastases few months later.

11. K. Giant-cell sarcoma of tibia. Treated by curettage and carbolic. Well six months later.

12. Giant-cell sarcoma of radius. Clinical, X-ray and microscopic diagnosis. Resection later recurred in adjacent ulna. Amputation followed by metastases in lung. One year later death.

13. T. Seen in consultation. Giant-cell sarcoma of ulna. Resection performed by Doctor Bloodgood, with implantation of bone. Patient well ten years later.

14. R. Giant-cell and spindle-cell sarcoma of upper end of fibula, operated upon by Doctor Hogue and myself. The wound was fulgurated with the Keating-Hart apparatus. Gas bacillus gangrene developed three days later necessitating immediate amputation. The patient made a good recovery and was in good health eight years later.

## PROGNOSIS AND TREATMENT OF GIANT-CELL SARCOMA

15. K. Giant-cell sarcoma of upper end of tibia treated by curettage. Patient remained well for four months when he was lost sight of.

16. S. Giant-cell sarcoma of lower third of femur treated by curettage followed by amputation by Doctor Hartwell. The patient remained well for eleven months and then developed metastases to the iliac glands and lung which proved fatal. This case had two types of giant cell, one of the benign epulis type, one of the malignant type.

### GROUP IV

#### *Cases Treated by Toxins Alone or Toxins and Surgery*

1. D. Central tumor lower end of radius, complete destruction of two and one-half to three inches of bone; bony shell destroyed. Treated with systemic injections of mixed toxins of erysipelas and *Bacillus prodigiosus* for four months. Patient made a complete recovery with full restoration of function and regeneration of bone; well some years later. Bone Sarcoma Registry diagnosis: benign giant-cell tumor.

2. F. Giant-cell sarcoma of lower end of radius, treated by curettage (amputation advised by Dr. Frank Hartley). Patient recovered under six weeks' treatment with toxins; the pathologic fracture reunited, and she is in excellent condition nineteen years later.

3. S. Central tumor of lower end of radius (clinical and röntgenological diagnosis was that of giant-cell sarcoma). Biopsy performed but no curettage. Microscopic diagnosis: giant- and spindle-cell sarcoma. Treated with toxins for six weeks. Patient made a complete recovery and was well when last traced, three years later.

4. McC. Giant-cell sarcoma of lower end of femur, treated by curettage and bismuth paste by another surgeon. Further curettage performed to control infection. Toxins given for several months. Another infection developed one year later necessitating amputation; no tumor found in femur. Patient later died of nephritis.

5. S. Giant-cell sarcoma of lower end of femur. Biopsy without curettage. Toxins given for several months. One year later a pathologic fracture occurred with injury to popliteal artery, necessitating amputation. Patient well ten years later.

6. B. Central tumor of upper end of humerus of rapid development. Imme-



FIG. 22.—Preceding case, March, 1926.

diate amputation performed followed by a short course of toxin treatment. Microscopical diagnosis: giant-cell sarcoma of epulis type. Patient developed pulmonary metastasis and died about a year later.

7. T. Giant-cell sarcoma of lower end of femur, extension. Amputation performed in another hospital. Prophylactic reduction with toxin by Doctor Coley. Well six years when last traced.

8. G. Giant- and spindle-cell sarcoma of lower end of femur involving knee-joint. Biopsy but no curettage. Amputation advised by Doctor Gibney and myself but refused by patient. Treated with mixed toxins alone. Patient alive and well, with

two inches' shortening, twelve and three-quarters years later.

9. Giant-cell sarcoma of femur. Biopsy revealing very large, inoperable tumor. Treated with few doses of toxins but with little effect. Death occurred in few months, undoubtedly from a highly malignant, osteogenic sarcoma. (Clinical diagnosis in this case, malignant bone tumor.)

10. L. Giant-cell sarcoma of upper end of femur, treated by curettage and prolonged toxins treatment given at Montefiore Home for Incurables under my direction. Patient made a complete recovery and was well eight years later. Microscopic diagnosis made by Prof. T. M. Prudden.

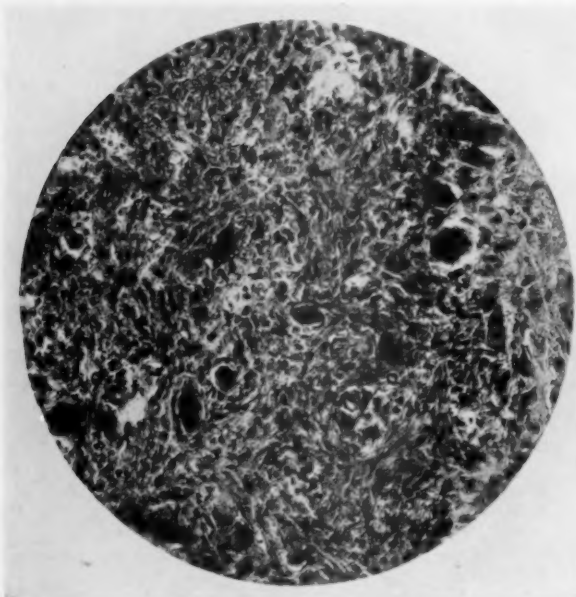


FIG. 23.—Preceding case.

11. C. Giant- and spindle-cell sarcoma of femur, inoperable. Treated with few doses of toxins but with no effect. Patient not traced further. This was, undoubtedly, a malignant osteogenic sarcoma mistaken for a giant-cell sarcoma. Patient undoubtedly died.

12. S. Giant-cell sarcoma of lower end of femur. Curettage followed by toxin treatment. Wound became infected, and knee-joint became involved, necessitating amputation. Patient well ten years later.

13. R. Giant-cell sarcoma of lower end of femur. Biopsy and injections of toxins given for few weeks. Amputation performed followed by prophylactic toxin treatment for several weeks. Patient developed metastases to pelvic bones and lungs, and died three years after amputation. (Clinical diagnosis: highly malignant bone tumor.)

14. G. Very extensive giant-cell sarcoma of dorsal spine, with complete paralysis of bladder, rectum and lower extremities. Patient lost fifty pounds in weight. Treated with mixed toxins alone from February to May, 1902. Rapid and very marked improvement followed; patient able to walk with crutch in September, and with cane in October. Complete recovery took place. Patient married, has three children, and is in excellent health twenty-five years later. He was shown at a conference at the Memorial Hospital, twenty-two years after treatment.

Three other cases treated by toxins after exploratory operation by Dr. H. DeB.



## PROGNOSIS AND TREATMENT OF GIANT-CELL SARCOMA

Barss at the University of Michigan Clinic, are reported in full in my paper on giant-cell sarcoma, March and April, 1924, *ANNALS OF SURGERY*. Limb saved in two cases. All their patients well over five years.

NOTE: Cases 9 and 12 should hardly be included in this group as they were both rapidly growing bone tumors, undoubtedly malignant, and inoperable at the time they came under observation. This paper is based upon a study of primary operable tumors, presumably giant-cell sarcoma.

15. C. Giant-cell sarcoma of tibia, treated by curettage and toxins. Recurrence six months later treated by second and incomplete curettage. Infection developed, necessitating amputation. Patient well six years later.

16. R. Round- and giant-cell sarcoma of upper end of tibia, treated by curettage by Doctor Steinhardt. Patient then referred to me for prophylactic toxin treatment. Well twelve years later.

### GROUP V

#### *Cases Treated with Toxins and Radium or Toxins and X-rays and Radium*

1. S. Giant- and spindle-cell sarcoma of the lower end of the femur with extensive involvement of knee-joint. Amputation advised by every surgeon who had seen patient, including myself, but refused. I did a very extensive curettage, finding upper end of tibia involved by tumor the size of a hen's egg. Cavity was kept clean with Dakin's solution. Toxin treatment begun on fourth post-operative day and continued for three months. Small sinus remaining was treated with radium pack and steel needle (100 mc. radium emanations) left in for three hours. Patient made a complete recovery with no shortening, and was able to walk without perceptible limp. She remained well for eight years and then died of hemorrhages from child birth.

2. F. Giant- and spindle-cell sarcoma of upper end of tibia involving five inches; bone completely destroyed with only a thin shell of cartilage remaining at upper end; treated with curettage and toxins. The destroyed area filled up with healthy granulations. Owing to an attack of "grip" the treatment was suspended, during which interval, the tumor recurred and grew rapidly. Second curettage performed followed by another recurrence. Under prolonged toxins and one radium treatment 10,000 mc. hours, the patient made a good recovery, and is well at present, eleven and one-half years later.

3. F. Benign giant-cell sarcoma of lower end of radius, treated by curettage and carbolic acid. Disease recurred within a few weeks but disappeared under toxin treatment. A second recurrence took place six weeks later. Radium treatment given for next four months, during which the disease steadily progressed. Toxin treatment resumed and kept up for three months. The tumor again disappeared, and the patient is free from recurrence six and one-half years later.

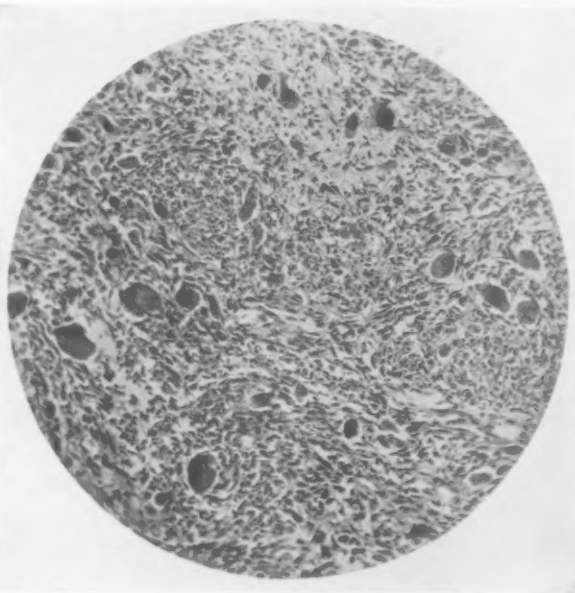


FIG. 24.—Case of Doctors Finch and Gleave, Sheffield, England.

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4. P. Benign giant-cell sarcoma of humerus. Clinical and Röntgen-ray diagnosis: cyst. Microscopic diagnosis (Ewing): giant-cell sarcoma. Recurrence after curettage. Toxins and radium treatment. Patient in good health with a useful limb, nine years later.

5. K. Giant-cell sarcoma of lower end of tibia, recurrent after two operations; treated by long-continued toxins four months and Röntgen-ray. The patient made a complete recovery and is well at present, twenty-three years later.



FIG. 25.—Cellular giant-cell sarcoma of lower end of femur (diagnosis made after curettage in 1924). Patient treated with toxins and X-rays. Some improvement; tumor later increased in size; pathologic fracture occurred. Amputation performed (diagnosis after amputation, benign giant-cell tumor).

6. G. Giant-cell sarcoma of tibia. Röntgen-ray treatment for two years. Pathologic fracture necessitating amputation. Toxin treatment given as a prophylactic. Patient well two and a half years later.

7. F. Very extensive giant-cell sarcoma of ileum treated with radium in Paris. Disease recurred. At the time of my first observation, the patient had a very large, inoperable tumor, and she was in a very weak and emaciated condition. Under two months' toxin treatment, the tumor softened and broke down. An extensive curettage was performed, following which the patient made a good recovery and remained well for five years, when she developed metastasis, which proved fatal.

8. H. Giant-cell sarcoma of lower end of femur, very cellular. Thorough surgical removal of diseased portion followed by carbolicization; radiation, and toxin treatment given. At the end of one year there

was distinct evidence of further extension of disease and gradual increase in bone destruction. A pathologic fracture occurred, necessitating amputation. The patient is free from recurrence one year later. First microscopic examination by Doctor Ewing, whose diagnosis was that of benign giant-cell tumor, rather cellular; prognosis guarded. Second microscopic diagnosis by Doctor Ewing after amputation was that of benign giant-cell tumor.

9. C. Central sarcoma of upper end of humerus following recent fracture. Exploratory operation. Microscopic diagnosis by Doctor Ewing and Doctor Bloodgood was that of benign giant-cell tumor. Treated with toxins and radium. The tumor continued

## PROGNOSIS AND TREATMENT OF GIANT-CELL SARCOMA

to increase in size but later began to decrease and at present, four years later, there is scarcely any evidence remaining. The patient is in good general condition but the arm is practically useless from musculo-spiral paralysis, present when the patient came under my observation.

### CONCLUSIONS

1. Giant-cell sarcoma, or "giant-cell tumor" as it is designated by most pathologists to-day, while in the great majority of cases, a benign or at least only locally malignant lesion, should still be classed as a sarcoma since in certain cases it has all the clinical features of a malignant bone tumor causing death by metastases.

2. In the majority of cases, the clinical and Röntgen-ray evidence will permit a diagnosis of benign giant-cell sarcoma; but in about 20 per cent. of the cases, it is impossible to differentiate the benign from the malignant type without the aid of a microscopic examination.

3. It is not always possible to differentiate the malignant from the benign cases by the clinical, Röntgen-ray and microscopic data.

4. It is possible to cure the majority of benign giant-cell sarcoma by curettage and carbolic acid or zinc chlorid. If the disease recurs, repeated curettage may be necessary. If the destruction of bone is so great that a pathologic fracture develops rendering the limb useless, amputation may be necessary; but not always so, as in a number of cases firm union has later taken place and the patients have remained permanently cured.

5. Largely through the splendid work of Doctor Herendeen, it is now possible to state definitely that giant-cell sarcoma can be cured by radiation. Whether a larger proportion can be cured by this method than by curettage, we are at present unable to determine for lack of a sufficient number of cases treated by radiation that have been followed to end-results.

6. The time required to effect a cure by radiation is considerably longer than that required by operative treatment or by toxins, with or without curettage, and hence the period of disability is prolonged.

7. The chief disadvantage of radiation as a routine, primary method of treatment of giant-cell sarcoma lies in the fact that in a considerable number of cases, the diagnosis of benign giant-cell sarcoma cannot be made from clinical and Röntgen-ray data alone.

8. It is possible to cure benign giant-cell sarcoma, and even far advanced borderline cases (giant- and spindle-cell sarcoma) by injections of the mixed toxins of erysipelas and *Bacillus prodigiosus* without other treatment. Furthermore, it is possible to cure these cases by a combination of toxins and radiation or toxins and curettage.

9. It is possible to cure these cases most rapidly and most certainly by surgery (curettage) followed by toxins. This method requires a much shorter period of disability and is not associated with greater risk; and, in my opinion, it is at present, the method of choice.

# THE SURGICAL TREATMENT OF TUBERCULOUS GLANDS OF THE NECK

AN ANALYSIS OF A SERIES OF 140 CASES

By HOWARD M. CLUTE, M.D.

OF BOSTON, MASS.

FROM THE LAHEY CLINIC

WITHIN the last fifteen years, 140 patients have come to us because of troublesome glands in the neck. In 131 cases a clinical diagnosis of tuberculous glands of the neck was made and was verified at operation. In 9 cases the diagnosis was doubtful, but in 7 of these the possibility of tuberculosis was considered. As such cases are illustrative of the difficulties which may occasionally arise in differential diagnosis, they are included in the following discussion.

The literature seems divided between advocates of surgery, of X-ray and of radium in the treatment of tubercular glands of the neck. Because we have a goodly series of cases extending over a sufficient period of years to make a study of end-results worthwhile, we have undertaken a detailed review of our cases, and have made every effort to learn the present condition of each patient in the series, either through personal examination, or questionnaire, hoping that this would throw some light on the advisability and efficacy of surgical treatment.

*Age and Sex.*—Our group of patients shows a definite preponderance of females, there being 93 females and 47 males. As would be expected in a clinic not limited to children's surgery, the age variation of patients was very wide: six patients were less than one year of age, and three were between sixty-one and sixty-five years. The actual age incidence for the entire group is shown in Table I.

TABLE I.

*Age Incidence in 129 Cases.\**

Age	No. of cases	Age	No. of cases.
Under 1 year.....	6	31 to 35 years.....	5
1 to 5 years.....	17	36 to 40 years.....	3
6 to 10 years.....	17	41 to 45 years.....	3
11 to 15 years.....	9	46 to 50 years.....	3
16 to 20 years.....	17	51 to 55 years.....	9
21 to 25 years.....	15	56 to 60 years.....	2
26 to 30 years.....	20	61 to 65 years.....	3
Under 30.....	101	66 to 70 years.....	0
			28

\* Age not recorded in 11 cases.

*Location.*—The location of the glands was definitely stated in 85 of the case histories. Twelve cases had glands in either the right or left sub-

# TUBERCULOUS GLANDS OF THE NECK

maxillary triangle (6 in each); 10 in the right posterior cervical region, 2 in the left; 25 in the right anterior cervical region; 24 in the left; 1 case had glands limited to the submental region; one showed subclavicular glands, and one patient had a large gland just above the sternal notch. In 9 cases the glands were bilateral, the location not being otherwise stated.

*Duration and Symptoms.*—The condition found on the first examination of these patients showed clearly the possible stages in the progress of the tuberculous condition. Relatively few patients were seen soon after the onset of the disease, when the glands were firm and showed no evidence of necrosis or caseation. In the 100 cases in which the duration of the disease before we saw the patient was recorded, it varied from 3 days to 45 years. In 37 cases the duration was less than a year; in 62, less than 2 years; and in 80, less than 5. Table II shows the actual duration before operation for the 100 cases.

TABLE II.  
*Duration of Glands Before Admission to the Clinic.\**

Time	No. of cases	Time	No. of cases
Several days.....	2	1 year.....	12
2 weeks.....	4	2 years.....	13
3 weeks.....	1	3 years.....	8
4 weeks.....	2	4 years.....	4
1 month.....	1	5 years.....	6
2 months.....	3	6 years.....	3
3 months.....	5	7 years.....	2
4 months.....	2	8 years.....	1
6 months.....	6	9 years.....	0
7 months.....	1	10 years.....	4
8 months.....	1	11 years.....	1
Several months.....	10	12 years.....	1
10 months.....	1	13 years.....	1
<i>Under 1 year</i>	—	17 years.....	2
	39	23 years.....	1
		40 years.....	1
		45 years.....	1
			61

\* Not stated in 40 cases.

From the clinical notes made when the patient was first examined at the time of admission, it seems fair to assume that at least 65 of the 140 cases had either caseation or abscess formation. In addition there were 12 patients who had a discharging sinus in the neck as their chief complaint. This shows clearly that many cases only come to surgery after the tubercular process has gone on for a long time, either with no treatment, or with treatment which fails to eradicate the disease completely, early in its course.

*Previous Infection.*—In 19 cases we could elicit a history of previous infection which seemed definitely related to the occurrence of the glands. In 18 cases there had been preceding tonsillitis. Of these, 14 had had their tonsils and adenoids removed. Only one case, so far as we know, had shown tuberculous tissue in the tonsil on pathologic examination. One case devel-



oped cervical glands following diphtheria; one after influenza; and one after scarlet fever. In 9 cases there had been intermittent subsidence and recurrence of the glands in the neck.

One patient had a definite ulceration of his lower lip which preceded the development of the glands in the sub-maxillary triangle. One stated that his neck swelled after he had received a blow. In one case the tuberculous glands were associated with a multiple colloid adenomatous goitre. Two patients had a history of syphilis.

*Previous Treatment.*—The variety of treatment which had been instituted prior to the patients coming to the Clinic is interesting, and is shown in Table III, for the 45 cases in which it was recorded. Undoubtedly other methods have been employed, of which we have no record.

TABLE III.  
*Previous Treatment in 42 Cases.*

Incision and drainage.....	17
Black salve.....	1
Hygienic treatment.....	1
Excision.....	3
5 previous operations.....	1
Application of ice or iodine (to allay swelling).....	1
3 biopsies by 3 surgeons.....	1
2 previous operations.....	1
1 previous operation.....	3
Alpine lamp.....	2
Tuberculin inoculations.....	2
Massage.....	1
Operation for peritonitis with multiple abscesses.....	1
X-ray treatment.....	7

*Symptoms and Cosmetic Effect.*—The chief symptom which brings the patient with tuberculous glands of the neck to the surgeon is the unsightliness of the tumor. Pain and tenderness were mentioned as an outstanding feature in only 29 cases. Occasionally redness was noted.

*Differential Diagnosis.*—In the differential diagnosis of glands of the neck, we must consider 5 possible lesions: (1) acute non-tuberculous adenitis, (2) Hodgkin's disease, (3) branchial cysts, (4) goitre, and (5) malignancy.

1. *Acute Non-tuberculous Adenitis.*—This is of sudden onset after very definite preceding infection, such as acute tonsillitis, a discharging ear, infected teeth, or a furuncle of the face. The usual course is limited to two to four weeks. Within this time either a frank abscess will develop or the glands will disappear in the majority of cases.

2. *Hodgkin's Disease.*—This resembles tubercular glands of the neck very closely when it first appears as a glandular enlargement in the cervical region. In many cases it is impossible to differentiate the two clinically, and one must wait until microscopic examination of a specimen has been made before the true diagnosis is known. In general, however, we find that in

## TUBERCULOUS GLANDS OF THE NECK

Hodgkin's disease glands are often present in the axillæ or groin, as well as in the neck, and the spleen is frequently palpable. Examination of the glands themselves shows them to resemble a bunch of grapes, each gland tending to be distinct from its neighbor. Adhesion to the surrounding structures is less marked in Hodgkin's disease than in tuberculous glands. Caseation and necrosis are, in our experience, unknown.

3. *Branchial cysts* may resemble a large tuberculous abscess very closely. They are usually situated either to the right or left of the midline, lying beneath or mesial to the sternomastoid, most frequently at the level of the upper border of the thyroid cartilage. They often fluctuate in size as does a tuberculous gland. They are painless unless they become infected.

Of the 3 cases occurring in this series, two were thought to be tuberculous glands, and in one the possibility of an infected branchial cyst was considered preoperatively. The fact that the tumor has been present for many years is one of the few points that may direct one to the correct diagnosis. Of course if a dimple occurs



FIG. 1.—Tubercular glands in right submaxillary triangle. In removing glands in this location the incision must be placed well below the lower border of the mandible in order to avoid the inferior branch of the facial nerve which goes forward to supply the small muscles of the mouth.

over the lower attachment of the sternomastoid, one should immediately suspect the presence of a branchial cyst.

4. It is unusual for *thyroid enlargement* to resemble tuberculous glands of the neck. We have, however, had one patient in whom there was a freely movable, definitely encapsulated tumor just above the suprasternal notch; and about 4 cm. in diameter, which clinically resembled very closely an adenoma of the thyroid. The fact that it did not move with deglutition, however, made us believe that it was not associated with the thyroid gland.

In 2 cases we have found a goitre present with numerous glands on each side of the neck. Clinically we considered one of these to be Hodgkin's disease associated with a goitre, and the other malignancy of the thyroid with enlargement of the cervical glands. Pathologically the first case was found to be leiomyosarcoma with early Hodgkin's disease, while the second case was

simple adenomata of the thyroid with associated tuberculous glands of the neck.

5. When *malignant glands of the neck* occur, secondary to carcinoma of the tongue or jaw, the primary lesion points the way to the correct diagnosis of the cervical enlargement. With sarcoma of the cervical glands, the tumor is distinctly of the type which is characteristic of malignancy. It is, as a rule, firm, adherent, indurated, immovable. It obviously encroaches upon

the neighboring structures. There is no division of the mass into individual glands.

In tuberculous glands of the neck, the history is as a rule one of chronicity; pain and tenderness are not remarkable in the early stages; frequently the history will show periods of enlargement and recession. Usually, before abscess formation occurs, the mass is movable and does not appear to be involved in surrounding structures. Although numerous small glands may be felt close to the tumor, these do not have the typical isolated feeling which is characteristic of Hodgkin's disease. Fever is more



FIG. 2.—Tubercular abscess over the middle of the left sternomastoid at about the level where the spinal accessory nerve is crossing the neck to enter the trapezius muscle. Incisions of abscesses in this location must be carefully made to avoid possibility of spinal accessory injury.

common with tuberculous glands than with the other lesions noted. It is, however, true that in diagnosing the enlargement of the cervical glands, there are many cases in which one cannot come to a definite conclusion until a gland has been removed and examined microscopically.

Occasionally in the uncertain cases of cervical glandular enlargement, an X-ray of the chest will show marked enlargement of the mediastinal glands, consistent with Hodgkin's disease, and will in that way be of definite value in making the diagnosis. Usually, however, when glands are present in the neck and there is marked enlargement of the mediastinal glands, there will be such generalized adenopathy that the diagnosis of Hodgkin's disease or lymphoblastoma will readily be suspected by clinical findings alone.

In connection with differential diagnosis it is interesting to consider II

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of our cases in which clinical diagnosis proved difficult, and to check this clinical diagnosis with the pathologic report on the operative specimen. (Table IV.) It is noted that we had been unable to decide before operation whether the diagnosis should be tuberculous glands or Hodgkin's disease in 5 of these cases. In these 5, the pathological diagnosis showed the presence of Hodgkin's disease in two cases, and of tuberculosis in two cases, while the fifth proved to be carcinoma metastatic from some undiscovered focus.

One patient presented clinically signs of Hodgkin's disease and an adenomatous thyroid; pathologically this was reported as early Hodgkin's disease with lympho-sarcoma. In a second patient we found many glands in each supra-clavicular region associated with an adenomatous thyroid. Clinically we believed the goitre to be malignant with associated glands in the neck. At operation, however, we were surprised to find a large, partly substernal adenomatous thyroid and many tuberculous glands. The goitre and the glands were removed in two operations with a most satisfactory clinical result.

It is of interest to note that in only one case was a definite diagnosis of tuberculous glands made which proved pathologically to be Hodgkin's disease.

TABLE IV.  
*Differential Diagnosis in Eleven Cases*

<i>Clinical diagnosis</i>	<i>Pathologist's report</i>
Case 1. Hodgkin's disease or tuberculous glands.	Hodgkin's disease.
Case 2. 3 biopsies elsewhere, Hodgkin's suggested, clinically Hodgkin's.	Tuberculous lymphadenitis.
Case 3. Tuberculous glands or Hodgkin's.	Tuberculous cervical lymphadenitis.
Case 4. Hodgkin's, sarcoma, or tuberculous glands.	Hodgkin's disease.
Case 5. Possibly Hodgkin's associated with goitre.	Early Hodgkin's; malignant lymphoma.*
Case 6. Tuberculous glands or Hodgkin's disease.	Adenocarcinoma—metastatic.*
Case 7. Carcinoma of thyroid with metastasis or Hodgkin's disease.	Tuberculous glands and adenoma of thyroid.
Case 8. Branchial cyst or tuberculous glands.	No pathological report. Operative diagnosis; broken-down tuberculous gland with pus.
Case 9. Tuberculous glands.	Hodgkin's disease.
Case 10. Tuberculous glands with abscess.	Branchial cyst.
Case 11. Tuberculous glands with abscess.	Branchial cyst with infection.

\* Both of these patients have died.

We are impressed with the fact that we have had three patients with infected branchial cysts which were diagnosed as tuberculous abscesses of the neck. In only one case was the possibility of an infected branchial cyst considered before operation.

*Surgical Procedures.*—One hundred and thirty-eight of the 140 patients in this series were operated on. One patient refused operation, and in one it was not deemed advisable. In 14 of the 138 cases several operations were performed. In some of these incision and drainage were necessary before

excision could be wisely undertaken; in others, subsequent operations were performed at the Clinic for recurrence.

We will first consider the initial operation in the 138 cases. In 31 instances minor operations such as incision and drainage, with curettement or cauterization of the cavity was employed. In 105 cases the glands were excised; in 2, a biopsy alone was performed.

*Incision and Drainage.*—We have had no experience with the puncture of tuberculous abscesses with hypodermic needles and the injection of bismuth paste and other similar preparations into the abscess cavity.



FIG. 3.—Unsightly keloid scar formation following the drainage for many months of a tubercular abscess of the cervical glands.

In general our procedure in the presence of an abscessed tuberculous gland or an exceedingly caseous tuberculous gland has been to make an incision over the fluctuant area and to open the abscess cavity widely. The grumous granulation tissue lining the cavity has been curetted thoroughly, and the cavity wall wiped out with full strength tincture of iodine. A small gauze pack has been inserted.

We remove this pack between three and five days after operation, replacing if need be a small rubber dam drain. Very frequently it has been our experience that these wounds heal rapidly, drainage persisting for only a few days. We have found that X-ray treatment carried on after this operation has been most satisfactory.

When the sinus following the incision and drainage of a tuberculous abscess of the neck fails to heal within a few weeks after operation, it is our belief that the sinus should be carefully dissected and removed. At its base will be found a broken-down gland, and this gland must be eradicated in certain cases before the wound will thoroughly heal. This procedure we found necessary in 14 cases of this series.

*Excision.*—Our practice in regard to complete excision of tuberculous glands of the neck is becoming more conservative every year. Ten years ago, we, in common with other surgeons, performed many extensive and radical dissections of the neck for large masses of tuberculous glands, whether or not more conservative measures had previously been tried. As



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we have studied our end results in these earlier cases from time to time, we have found that although the tuberculous glands have been satisfactorily removed, the scarring and the possibility of nerve lesions have been such as to indicate extensive operation less frequently than we had formerly believed. In fact, in late years, we have done practically none of the so-called radical dissections for tuberculous glands of the neck.

It is our present opinion that a large mass of tuberculous glands extending from the mastoid well down the jugular vein should receive heliotherapy or X-ray treatment for at least six months, before radical removal is considered. There are certain malignant cases of tuberculous glands of the neck in which the constitutional reaction from the active tubercular infection is marked and increasing, in which radical interference is definitely indicated in order to stop the progress of the disease. Operation here should be undertaken, but with particular care to preserve the spinal accessory nerve. Cases of this type are becoming much more rare in our experience in recent years, and in a general



FIG. 4.—Unightly deformity of the neck from atrophy of the sternomastoid muscle, irregular scar and the drainage of an abscess in a recurrent adenitis occurring years after the first operation.

way are in the group of so-called neglected cases who have gone for many months without any adequate treatment, while the disease rapidly progressed.

When a small group of definitely enlarged glands has been present in the neck for two months or over in a patient who has reached the age of five or more years, we believe that their early and complete removal is the safest and best treatment which can be instituted.

Abscesses and caseating glands have been most satisfactorily treated by incision, drainage, and curettage.

We have come to believe that post-operative X-ray treatment in all patients with tuberculous glands of the neck is of definite value. It is of course important that the X-ray treatment shall be given by one who is thoroughly trained in the principles of X-ray therapy. This form of treat-

ment is not indicated, in our opinion, in the presence of a tuberculous abscess until that abscess has been drained. It then hastens healing of the wound.

Tuberculous sinuses of long duration we excise when the dissection is not too extensive and the danger of nerve impairment not too great. If excision is inadvisable we open the sinus widely down to the caseating gland which lies at its base, and curette the entire tract and caseating gland. We then swab the entire area with full strength iodine and close it with a drain or small pack. X-ray treatment hastens the healing of the sinus.

In 33 cases in this series X-ray has been used post-operatively.

*X-ray Treatment.*—In this series of cases, we have used X-ray treatment when a new tuberculous gland formed in the scar of the operation, or in an area close to the original site of infection. In 4 cases of this type it seemed to us to be distinctly helpful. In 8 other cases of recurrent glands following operation, an abscess developed after the X-ray treatment and was incised with eradication of the lesion. In two of these cases we did not feel that the X-ray was of any help.

Dr. L. B. Morrison, of Boston, has carried out most of the X-ray therapy in our patients with tuberculous glands of the neck. He feels that X-ray hastens coagulation necrosis when it is once begun, and in these cases the formation of an abscess followed by incision and drainage with X-ray treatment is an excellent plan of procedure. If there is no necrosis present in the nodes he believes that they will disappear with properly adjusted X-ray treatment. He says, however, that in his experience there are probably 20 per cent. of cases of tuberculous glands of the neck which will not respond to X-ray treatment. There are two possible explanations for these cases in his opinion: (1) That the diagnosis is incorrect, and the patient has not tuberculous glands; and (2) that a secondary infection is present which prevents response to X-ray therapy. When calcification is present in the lymph-nodes, X-ray treatment is not indicated inasmuch as the process is already in a quiescent state and X-ray will not change the pathology.

#### DISCUSSION

The various alternatives to the use of surgery in the treatment of tuberculous glands of the neck are of course well known. One can find the most excellent authority for the exclusive use of hygienic measures; of X-ray therapy; of heliotherapy and the Alpine lamp. It must be borne in mind that tuberculous glands of the neck are rarely fatal, and that the disability is not, as a rule, great. The patient most commonly seeks treatment because of the unsightliness of the lesion, the chief desire in his mind being the reduction of the unsightly tumor and the prevention of a discharging sinus in the neck. In considering, therefore, the method of treatment which we shall employ in any given case, we should bear in mind first that a good cosmetic result is really the first consideration in the treatment. The second consideration of importance in selecting the type of treatment for any individual case is the length of time which treatment will involve. There are many

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patients who can ill afford either the time or expense involved in a satisfactory course of heliotherapy, X-ray therapy, or hygiene, which must needs be prolonged.

Before the patients in this series came to us for surgical treatment, hygienic treatment, so-called, had been carried out exclusively in one case, without improvement; local applications had been used in two cases; Alpine lamp in two; tuberculin injections in two; and X-ray treatment in seven. There were, of course, many of the group who had had previous operations. Seventeen had had repeated incision and drainage of abscesses; three had had previous excisions. In fact, one of the latter had had five previous excisions.

Our experience with *tuberculin treatment* in the Clinic has been extremely limited. Two of the patients in the group had had extensive tuberculin treatment before coming to the Clinic, without resulting cure. We have had no experience with the post-operative use of tuberculin.



FIG. 5.—Right shoulder drop following dissection of right side of neck seven years ago. Note that the fullness of the trapezius muscle is absent on the right side, the shoulder is lower than on the opposite side and is rotated forward. There is no evidence in this case of any further glandular enlargement and it is almost impossible to see the scar of the operation.

*Heliotherapy* in selected cases is undoubtedly very valuable. It must be remembered, however, that a period of six months to two years is needed in the average case of tuberculous glands for this type of treatment to be effective. If this amount of time can be taken, then this method, properly applied and supervised, is well worth consideration.

*X-ray treatment* is highly recommended by many physicians. Desjardins of the Mayo Clinic feels that surgery should no longer be considered the best method of treatment, and asserts that X-ray or radium treatment is distinctly the method of choice. He states that X-ray is preferable to radium in view of the fact that a more uniform dosage to the entire gland-bearing area is possible.

Bowing, also of the Mayo Clinic, says that the simple type of tuberculous adenitis offers the best results from radium treatment, the patient being meanwhile supported by general hygienic and dietary measures. If suppuration is present, curetting or drainage may be necessary. He advises repeating the radium treatments every six weeks until all signs of activity have disappeared.

Knox says that tuberculous glands slowly regress under X-ray treatment, but rarely disappear, and tend to become active again after a while. For this reason he believes it is advisable to remove them surgically after they have become quiescent.

In our experience X-ray treatment has frequently been of the greatest help when combined with surgery. The X-ray tends to make a hyperplastic node grow smaller. If it is not very carefully controlled, however, the hyperplastic node will break down so that absorption of the necrotic material is impossible and an abscess results. In suppurating glands which have been incised and drained, we believe that X-ray hastens the healing of the sinus. X-ray treatment cannot of course be used when skin erosion surrounds the tuberculous sinus; but in a sinus without surrounding skin involvement, X-ray frequently hastens recovery.

Regardless of what general method of treatment is to be adopted, we believe that the *original source of infection* of the glands should be eradicated, if possible. Thus removal of the tonsils and adenoids when indicated, the removal of abscessed teeth, and the eradication of foci of infection anywhere in the mouth, nose, or pharynx is very valuable. Whether this focus of infection should be attended to before the tubercular glands are removed is a mooted point. Excellent authorities advise removal of tonsils and adenoids first, and removal of the tuberculous glands two months later if they are still enlarged. Other authorities recommend the removal of tonsils, adenoids, and glands at one operation. Still others recommend the removal of the tuberculous glands first, and the subsequent removal of tonsils and adenoids. It is our feeling that the infected tonsils should be removed first, and at a later date the tuberculous glands attended to.

Handford states that in any individual case it must be clearly realized that no plan of treatment can insure a cure, and this has been borne out by our experience. Recurrence locally or elsewhere may occur.

*Preservation of Nerves.*—From our study of these patients it has again impressed us that the utmost care must be used in preserving the spinal accessory nerve. The disability and deformity resulting from the injury to the spinal accessory nerve and resulting paralysis of the trapezius or sternomastoid and trapezius is so severe that we wish to place the utmost emphasis upon this point. (Table V.)

The small branch of the facial nerve which lies beneath the mandible to supply the depressor anguli oris muscle is also frequently injured in dissections of the neck. Although the paralysis of this muscle is not disabling, nevertheless the drooping of one corner of the lip is noticeable, and in many cases annoying to the patient.

In 1922, we published a paper in which we called attention to the deformity and disability arising from spinal accessory paralysis after dissections of the neck. Since that time we have been particularly careful to isolate this nerve in all dissections which we carried near its course, and to preserve it at all costs.

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In investigating the end results in the series reported here we find that since our special attention has been directed to this condition as a result of previous study, our operations have tended to become much more conservative. It is most depressing to see girls and young women who were operated

TABLE V.  
*Cases of Nerve Injury*

Date of operation	Case	Spinal accessory injury	Facial nerve injury
1915.....	H.	Present, but not complete. Disability decreasing	
1924.....	R. K.		Although incision was placed low, she had "lip drop".
1918.....	E. G.	Sternomastoid cut. Bloc dissection neck. Nerve seen and preserved. Has paralysis and shoulder drop	
1922.....	W. H.	Nerve cut, though an attempt to save it was made. Shoulder drop	
1919.....	F.		Lip drop. Noticeable, but not disfiguring.
1914.....	E. J.	Nerve dissected out. Paralysis resulted and still persists. Bad shoulder drop	Noticeable lip drop.
1925.....	B. W.	Nerve preserved. Permanent partial sp. acc. paralysis. Shoulder drop	
1913.....	R. M.	Bloc dissection. Shoulder drop. Spinal curvature	
1918.....	T.		Lip drop. Not bad.
1926.....	Le P.		Right lip drop. Not bad.
1923.....	O'B.	Complete shoulder drop. Much disability. Dissection jugular	
1920.....	S.	Dissection jugular. Complete paralysis of trapezius and sternomastoid	
1925.....	M. H.	Spinal accessory severed and sutured. Now no paralysis	
1917.....	W.	Bilateral spinal acc. paralysis. Very bad deformity	
1915.....	P.	Paralysis sternomastoid. Paralysis trapezius improving. Marked atrophy and deformity	Lip drop—deformity diminishing.
1922.....	G.	Nerve preserved at operation. Temporary paralysis of trapezius.	

on many years ago by the bloc dissection method who have complete paralysis of their trapezius with accompanying shoulder drop, rotated scapula, disability of marked degree, pain with attempts at lifting the arm and even in one case curvature of the spine requiring orthopedic treatment.



The trapezius muscle is the chief muscle involved in the raising of the arms from horizontal to the vertical position. With the exception of the rhomboids and the levator anguli scapuli it is the only muscle that fixes the scapula toward the midline. It is to be remembered that the nerve supply to the trapezius muscle rises not only through the spinal accessory nerve, but also through the second, third and fourth cervical nerves; and that these unite within or beneath the sternomastoid to form the so-called "sternomastoid plexus", and then send fibres to the trapezius and levator anguli



FIG. 6.—Same patient as in Fig. 5 with the right arm elevated to the horizontal. Here the atrophy of the trapezius muscle is very evident.

scapuli. It is quite possible to have a partial paralysis of the trapezius through injury of some of the nerves before they leave the sternomastoid plexus. This is particularly prone to happen when the dissection is carried along the jugular, high in the neck, to the region of the mastoid process. It has been said that if the spinal accessory nerve is in-

jured that paralysis of the trapezius may not be complete, due to secondary innervation which the muscle receives from the upper cervical nerves. We feel very strongly, however, that little if any reliance should be placed upon this possibility, and that every effort should be made to preserve the spinal accessory intact wherever it is encountered. In many cases we have identified the spinal accessory and dissected it throughout its course amongst the tuberculous glands of the neck. Immediately after operation we have observed a trapezius paralysis, which disappeared, however, after a period of three to six months.

In two cases the nerve was cut and at the close of the operation sutured. These two patients have recently been reexamined, two years after operation, and found to have normal motion in their trapezius muscle. This we consider very valuable evidence that suture of the spinal accessory after it has been cut either by accident or intention should always be done.

Injury to the spinal accessory before it enters the sterno-mastoid muscle will result in a more or less complete paralysis of this muscle. Functionally we have seen no evidence of disability from this lesion. The resulting atrophy of the sterno-mastoid muscle, however, produces a very noticeable deformity of the neck. This was present in three of our cases. In one of these patients it seemed to us that the sterno-hyoid, sterno-thyroid and omo-hyoid muscles had also become markedly atrophied. This added greatly to the

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deformity of the neck. The nerve supply of the infra-hyoid group of muscles arises from the first three cervical nerves and the hypo-glossal trunk through the ansa hypoglossi. (Gray.)

*End Results.*—We have personally reëxamined 43 of the 140 patients in the Clinic within the last month, and have received answers to questionnaires from 40 of those who did not find it possible to come in for reëxamination.

*Patients Reëxamined in 1927.*—Concerning these 43 patients we can report the exact end results. Because of our particular interest in the occurrence of muscle atrophy from nerve injury at the time of operation in neck dissections, we have divided these cases into two groups:

*Group 1.*—Twenty cases which were operated upon five or more years ago. (We published our first paper on nerve lesions in 1922.)

*Group 2.*—Twenty-three cases were operated upon within the last five years.

*Group 1.*—The average lapse of time since operation in this group was nine and a half years. Ten of the patients had a persistent nerve lesion as a result of their operation. (Table V.) This is a high percentage of nerve lesions. In many of these cases, the operative notes state that the spinal accessory nerve was seen and carefully preserved, but in the majority of these patients a very extensive removal of the glands was carried out, frequently by a bloc dissection.

Of the group of 20, 14 have excellent scars; in 5 instances the scar is only fair; and in one it is unsightly.

In 4 cases there had been a recurrence of glands after the operation,

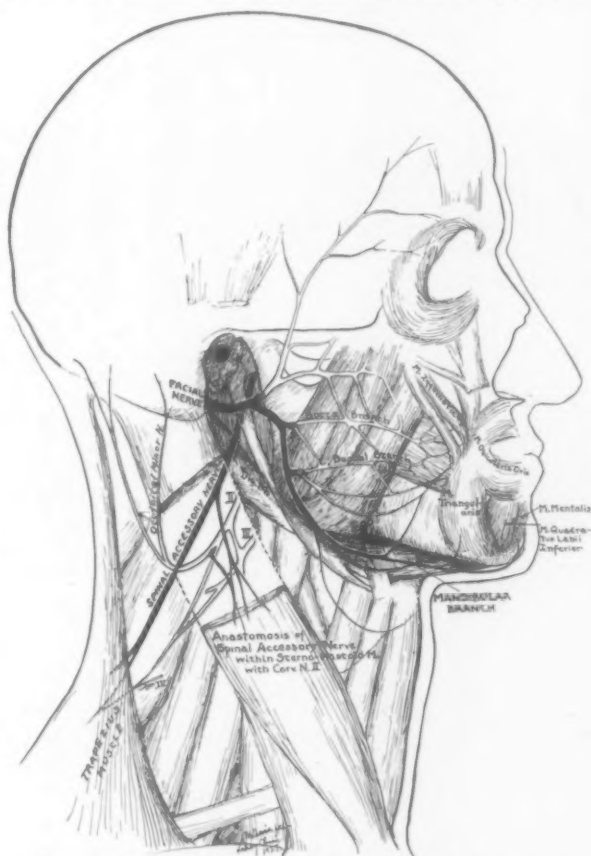


FIG. 7.—Diagram showing the course of the spinal accessory nerve and of the facial nerve. Note the sternomastoid plexus lying within or beneath the sternomastoid muscle in which the branches of the first and third cervical nerves may or may not join with the spinal accessory to supply the trapezius muscle. Note also that the mandibular branch of the facial nerve which supplies the small muscles about the mouth lies beneath the ramus of the mandible for a considerable part of its course.

some of which were controlled by X-ray treatment. Others had required further dissection.

*Group 2.*—Of this group, in which operation was performed within the last five years, that is, since we have given every possible attention to the avoidance of nerve lesions, there has been only one serious lesion post-operatively (two cases of slight lip drop). This occurred in a baby aged

thirteen months at the time of operation, who had a very extensive mass of active glands extending along the right jugular vein and seriously affecting her general health. With the exception of the trapezius paralysis which resulted from the operation, she is now in perfect health and has an excellent scar.

Of these 23 cases, the results may be termed perfect as regards condition of the scar, absence of recurrence, and of nerve lesions, in 15 cases. There has been a recurrence of glands, without symptoms, at the site of operation in 5 cases, and recurrence at a new site in 2 cases.

In one patient the results are excellent, except that the scar is slightly keloid.

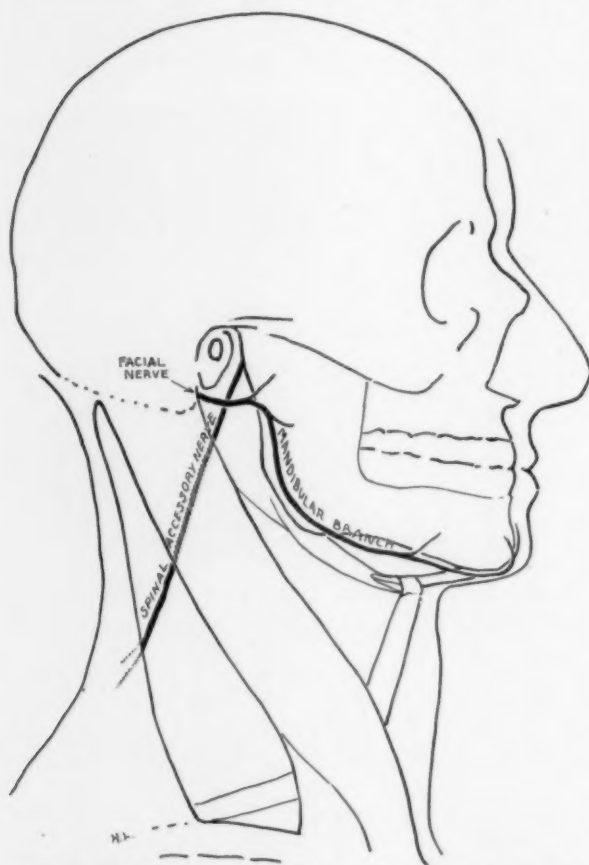


FIG. 8.—Schematic drawing to show the position of the spinal accessory nerve and the mandibular branch of the facial nerve. Incisions for the dissection of glands of the neck must be planned to avoid the possibility of injury of these nerves.

*Answers to Questionnaires.*—The following questionnaire was sent to all patients who did not come in for reëxamination at the time requested: 1. Do you consider yourself (a) cured, (b) partly benefited, (c) not benefited by the operation for tuberculous glands? 2. Have you required further surgery for this trouble since our last operation? 3. Has there been any abscess formation or drainage from the wound? 4. Have any other glands in your neck become swollen or prominent? 5. Have you any difficulty at present which you relate to the operation? 6. What is the present condition of the scar: (a) slightly noticeable, (b) noticeable, (c) ugly? 7. Have you had any evidence of tuberculosis elsewhere in your body. 8. Does any one else

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in your family with whom you are or have been closely associated suffer from tuberculosis in any form?

Twenty-seven patients reported that they considered themselves cured; four "partly benefited". Three patients had died, several years after operation, one of pneumonia, one of acute mania, and one of septicæmia. In one case a nerve lesion was reported, but the patient said that the accompanying deformity was decreasing. In three cases there had been a recurrence of glands. In one of these, the patient stated that she did not consider herself benefited by the operation, but that she had been considerably helped by radium treatment received elsewhere. A second had a subsequent abscess, which is now better, and another patient is having trouble with persistent bronchial colds.

In four cases the scar is reported as noticeable. In all others, it is apparently satisfactory.

### ILLUSTRATIVE CASES

CASE I.—Occasionally a patient has such an active tuberculous infection in the cervical lymph-nodes that her general health is seriously affected. In the case of Mrs. A. A., aged fifty-three years, this factor was the important one in the treatment of her condition.

She had noted a swelling in her neck six months before admission to the Clinic. This increased rapidly in size. She lost weight, had marked increase of fatigability, but otherwise presented no history of disease.

On examination a large mass was found, extending from the mastoid process nearly to the clavicle along the anterior border of the left sternomastoid. Indefinite deep fluctuation was present. Stereoscopic films of the chest showed an abscess in the lower left cervical region, overlying the apex of the lung, and extending down to the mediastinum, with enlargement of the mediastinal glands on the left, probably tuberculous.

An incision was made in the neck along the anterior border of the sternomastoid under ethylene oxygen anesthesia, and a large mass of glands found, and an abscess containing pus typical of tuberculous infection. The cavity was curetted gently, wiped out with full strength iodine, and closed with a cigarette drain. As soon as the wound was partly healed, Alpine lamp treatment was begun, and has been continued for the past six months.

The general condition of the patient has improved markedly in every way. She has gained weight; her color has improved; and her strength is now returning. As supplementary treatment, the patient was urged to expose her neck as frequently as possible to the direct sunshine. Now, six months after the drainage of the abscess, there is a very small granulating wound which oozes a small amount of caseous material. None of the glands which we previously felt in the neck can be identified.

It is obvious in this type of case that complete and thorough drainage, combined with Alpine lamp treatment, has been of distinct benefit, even though drainage from the wound has of necessity been long. Such a patient, in our opinion, might have done well had it been possible to excise the tuberculous glands soon after their onset. This being impossible in this instance, the conservative measure was of great advantage.

CASE II.—As an example of the results following X-ray treatment, the case of Miss R. H. may be cited. This young woman noted an enlargement of a gland at the left angle of the jaw four years before examination. This had varied in size from time to time. Shortly before she came to the Clinic in 1924, it had become larger and remained so. When we examined her, it was obvious that the gland had broken down and formed an abscess. This was incised and a large amount of pus evacuated. Following this, X-ray treatment was given her by Dr. L. B. Morrison.

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Six months later the wound was dry, and we were unable to detect any enlargement of the cervical lymph-nodes. A year later some enlargement of the gland recurred, but this also receded very rapidly under X-ray treatment.

CASE III.—The tendency to recurrence of tubercular glands of the neck after excision is shown in the case of Mr. J. Q. This man was first seen in 1920, when he had an enormous mass of caseous tuberculous glands extending over the posterior triangle of the neck on the left.

This was completely excised, the spinal accessory nerve being carefully preserved throughout its course. The wound healed by first intention.

In 1924, the patient returned with more enlarged glands in the left posterior triangle of the neck. These we excised, and the wound was soundly healed within two weeks of operation.

Pathological examination of the glands each time showed tuberculosis.

This man had had tonsillitis repeatedly and we had advised him to have his tonsils removed, but he neglected to do so.

Five months after the second operation, he returned with an abscessed gland in the left side of the neck, which we incised and drained. X-ray treatment was given before and after this incision, which possibly hastened his recovery.

In 1926, he returned again with several broken down glands on the left side of the neck following another attack of tonsillitis. He then decided to have his tonsils removed. The glands, however, persisted for a time, and it was necessary to excise them. Again the pathological report was tuberculous cervical adenitis.

The patient was last seen four months ago. No glands were palpable in his neck; his throat was clean; and his general health very satisfactory.

It seems to us that in this case recovery was markedly retarded by failure to remove the source of infection, and was only consummated after tonsillectomy in spite of repeated removal of enlarged glands, X-ray treatment, and general hygienic measures.

### SUMMARY

One hundred and thirty-one cases of tuberculous glands of the neck are discussed in detail, and the differential diagnosis considered in nine other doubtful cases. The end results have been carefully checked in 1927, to determine the advisability of surgical treatment, and the incidence of nerve lesions.

The mortality in the series reported is 0 per cent.

The best results were obtained in cases which came early for treatment, the scar being less noticeable, because extensive resection was not necessary and complete excision was possible. If operation is undertaken before the appearance of sinuses and abscesses, recurrence is rare. If these complications have arisen, the chances of complete cure are not as good.

In certain cases a combination of X-ray treatment and surgery gives excellent results.

For the average patient, who cannot afford the time or expense of prolonged hygienic treatment, surgery seems the method of choice.

Removal of all sources of infection is important. One case is reported in which permanent cure was considerably delayed because of failure to do this.

The incidence of nerve lesions within the last five years, since marked attention has been given to this unfortunate possibility, has been greatly diminished, only one case having had such a lesion.



## TREATMENT OF SURGICAL COLLAPSE OF THE LUNG

A METHOD INVOLVING REMOVING THE FIRST RIB THROUGH THE POSTERIOR TRIANGLE OF THE NECK, AND AT THE SAME TIME, IF DESIRED, AVULSING THE PHRENIC OR POSTERIOR THORACIC NERVE, OR BOTH

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FROM THE DIVISION OF SURGERY OF THE HEAD, NECK AND THORAX, COFFEY CLINIC

THE modern thoracoplasty, or surgical collapse of the chest, has been a boon to patients suffering from cavernous tuberculosis and suppurative lung conditions. Excluding the spirillum infections, when these conditions do not clear up under medical care, administered with an object of building up general resistance and establishing free oral drainage, artificial pneumothorax is indicated, if possible to attain.

In the suppurative lung conditions artificial pneumothorax is often impractical, because, (1) the diffuse inflammation has made the lung adherent to the chest wall; (2) the rapid formation of pus keeps the cavities distended; (3) bronchial fistulae are liable to develop; or (4) the abscess may rupture into the pleural cavity and impose an empyema upon a condition that is already exceedingly grave.

In cavernous tuberculosis, in order to collapse the cavities and give the lung absolute rest for a time sufficient to allow the disease to heal, continued artificial pneumothorax is ideal, for it offers hope of later allowing reexpansion of the part of the lung that is free from disease. Very often this is not possible because of fibrous and inflammatory adhesions between the visceral and parietal pleurae. If these adhesions are small and avascular the intrapleural pneumolysis of Jacobaeus, followed by artificial pneumothorax is effective. When the presence of large or vascular adhesions make the Jacobaeus method impractical, surgical collapse becomes necessary.

Adequate surgical collapse is impossible without the removal of a section of the first rib. The first rib forms a protective cage for the apex of the lung and forms the support and the line of fixation for the entire side of the thorax. The first rib is held up by the scaleni, anticus and medius.

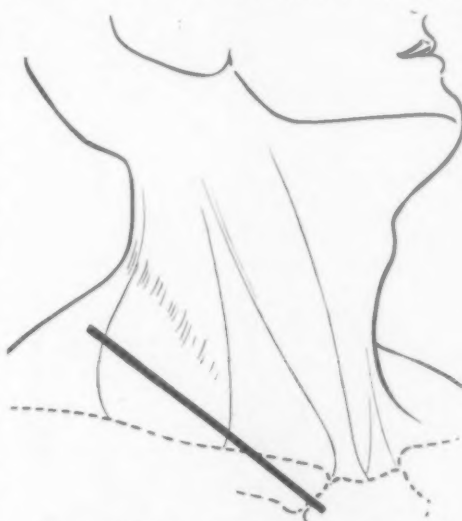


FIG. 1.—Diagram of the external surface of the posterior triangle of the neck, showing the line of incision.

The operations employed for the surgical collapse of the lung provide for the posterior removal of the first rib from below. This procedure has several drawbacks; first, the great trauma to the shoulder and its muscular support produced by the strong retraction which is necessary in elevating the clavicle to reach the posterior portion of this rib; second, the physical difficulty of removing a large enough section of the rib; third, the danger of injuring or cutting the subclavian artery as it arches over the rib immediately anterior to the most desirable location for cutting the rib; fourth,

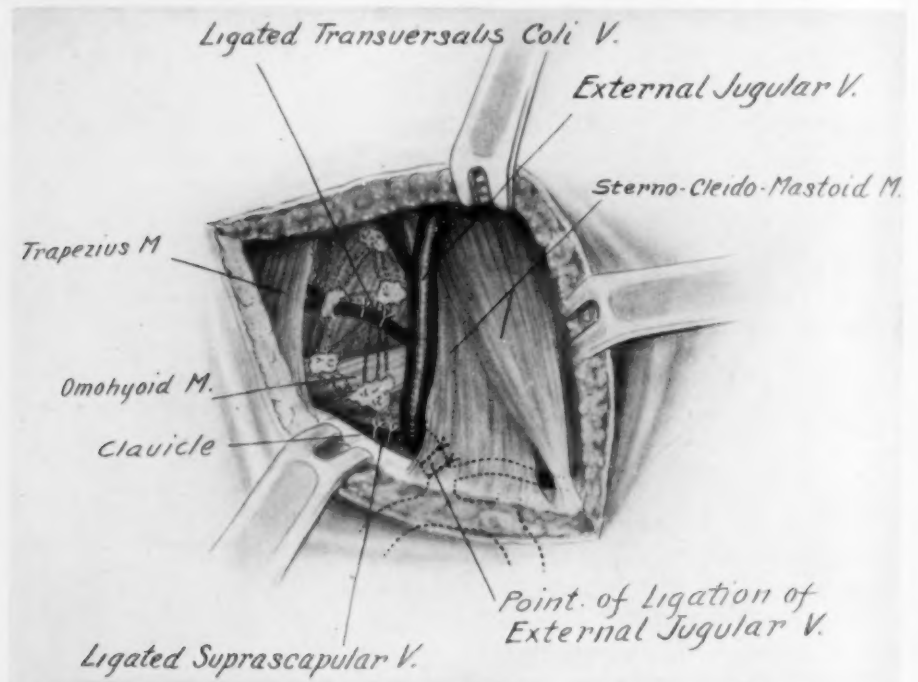


FIG. 2.—The skin and platysma have been retracted, disclosing the external jugular vein and its branches. Points for severance are indicated. The omohyoid muscle is seen through the lymphatic and fatty space behind the sterno-cleido-mastoid muscle.

the blind approach that is necessary and the consequent danger of leaving sharp spicules of bone which may puncture the artery or pleura later; fifth, the extended time that the patient is kept upon the operating table.

Having in mind the objective of overcoming these disadvantages and reducing the morbidity from surgical collapse of the lung, the author has devised an operation that simplifies the removal of the first rib and by gaining the collapse obtained from its removal renders further collapse more easy and diminishes the sum total of operative shock.

The patient lies upon his back on the table with the arms extended down the sides, and a sandbag placed under the shoulder of the involved side. The arm on the involved side is pulled further down the table and fastened while that of the opposite side is relaxed. This lowers the shoulder girdle on the involved side. The incision is made to bisect the angle, the apex of

## TREATMENT OF SURGICAL COLLAPSE OF THE LUNG

which is the posterior junction of the sterno-cleido-mastoid muscle and the clavicle, the sides of which are formed by the clavicle and the base of the neck. The incision starts at the trapezius border and ends at the manubrium, and penetrates the skin and platysma. (Fig. 1.) Retraction is made on the sides of the wound. The external jugular vein, coming down the posterior border of the sterno-cleido-mastoid muscle, and ducking behind this muscle, obtrudes itself. (Fig. 2.)

The external jugular vein is dissected downward to a point below where the suprascapular vein branches off posteriorly. This vein is doubly ligated

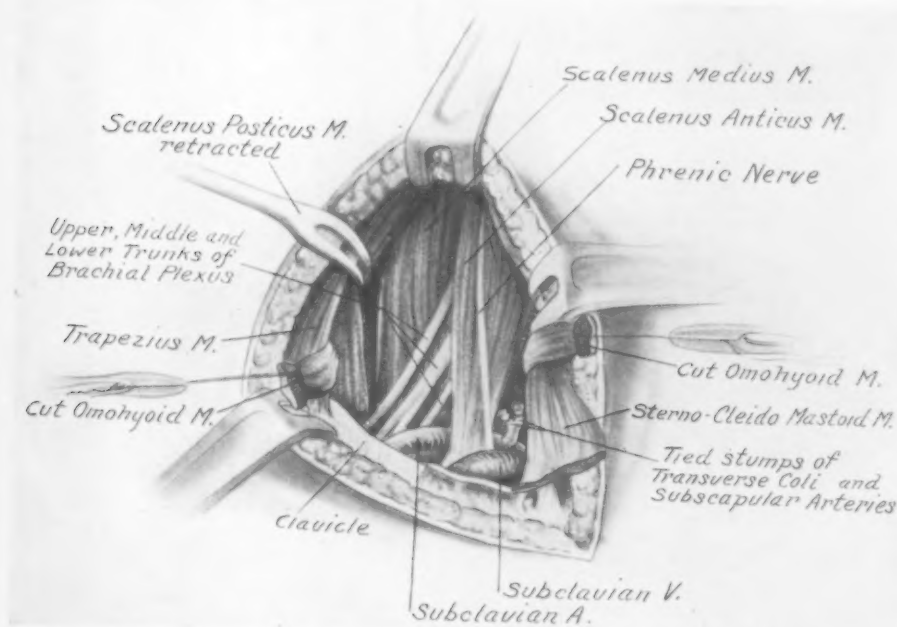


FIG. 3.—The transverse colli and suprascapular arteries have been ligated and cut. The omohyoid has been cut and traction sutures attached to its ends to act as retractors. The lymphatic and fatty tissues have been dissected away, exposing the lateral region of the first rib.

and cut. The external jugular vein is followed upward to its next posterior branch, the transverse collic vein. This is doubly ligated and cut. The external jugular vein is then doubly ligated and cut below the tied stump of the suprascapular vein and above the anterior branching of the anterior jugular vein. The posterior two-thirds of the clavicular portion of the sterno-cleido-mastoid muscle is cut across slightly above its attachment to the clavicle, leaving sufficient muscle and tendon attached to the clavicle for resuturing. The upper severed portion of the sterno-cleido-mastoid muscle with the upper tied stump of the jugular vein is retracted forward. The operator finds himself over a space, usually filled with fat and lymphatic glands. The content of this space is carefully dissected out, keeping watch for two transverse arteries, below, the suprascapular, above, the transverse colli or transverse cervical, both, branches of the thyroid axis which emanates

from the subclavian artery immediately anterior to the scalenus anticus muscle. These are doubly ligated and cut at a point where they cross the scalenus anticus muscle. The peripheral branches of the brachial plexus are disregarded. The omohyoid muscle is doubly ligated and cut where it crosses the scalenus anticus muscle, traction sutures being left on each end in order that these ends may be used for retractors. All fat and glandular tissue is dis-

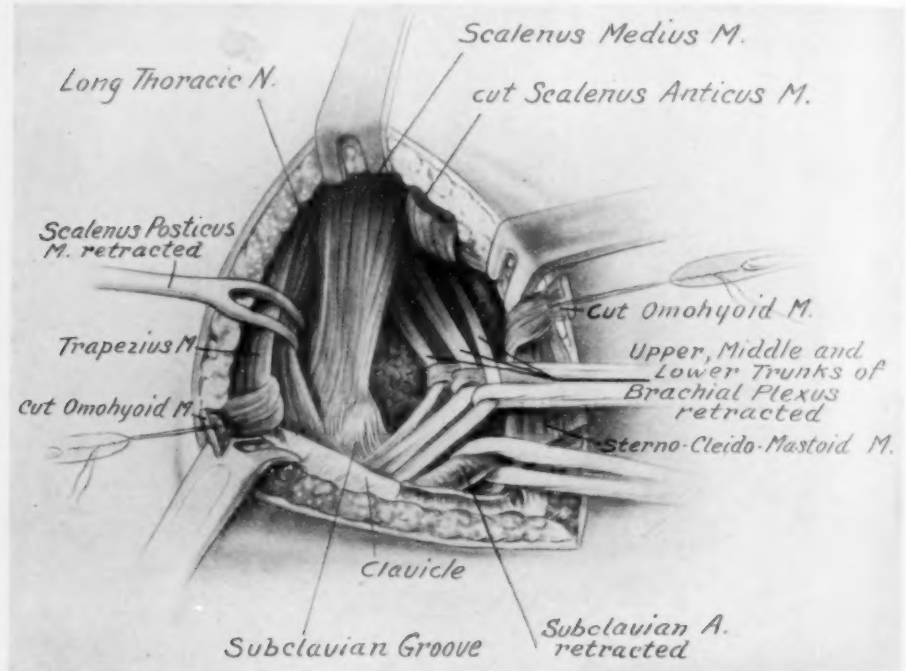


FIG. 4.—The scalenus anticus muscle has been cut and has retracted upward. The phrenic nerve has been avulsed. The subclavian artery has been retracted into the space formerly occupied by the scalenus anticus muscle and the brachial plexus has been retracted forward, uncovering the subclavian groove. The long thoracic nerve is seen coming through the scalenus medius muscle, running down its latero-posterior side and crossing the first rib.

sected away and the overlying structures are retracted backward and forward. No sharp retractors should be used from this time on. (Fig. 3.)

There exposed, from the sterno-cleido-mastoid muscle backward, lie the subclavian vein, arching over the first rib in front of the scalenus anticus muscle attachment to the first rib, the phrenic nerve running down the upper anterior surface of the scalenus anticus muscle and slipping mesially off its anterior side; posterior to the attachment of the scalenus anticus muscle the subclavian artery arching over the rib between the scaleni, anticus and medius, and above the artery, emerging from between these muscles are to be seen the upper middle and lower trunks of the brachial plexus. The operation to this point resembles the preliminary steps in the operation for the removal of cervical rib as described by Adson and Coffey.<sup>1</sup>

Attention is then fixed upon the phrenic nerve. If the diaphragm is to be

<sup>1</sup> ANNALS OF SURGERY, June, 1927, vol. lxxxv, pp. 839-857.

## TREATMENT OF SURGICAL COLLAPSE OF THE LUNG

paralyzed the phrenic nerve is cut and the peripheral end is avulsed. If not, the nerve is freed from the muscle so that the muscle, which is soon to be cut, will not pull upon the nerve as the muscle retracts. The scalenus anticus muscle is then severed at its attachment to the first rib. It is well to leave a portion of the muscle attached to later form a bed for the subclavian artery. Immediately within lies the pleura, forward the carotid sheath.

A gauze tape is slipped around the subclavian artery and it is gently

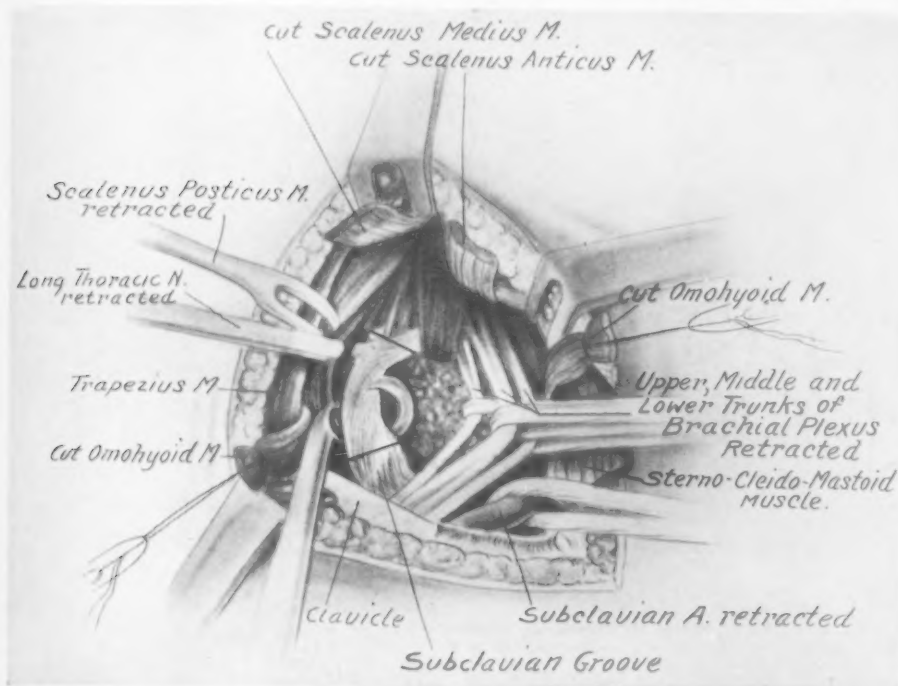


FIG. 5.—The scalenus medius muscle has been cut showing the inward and upward curving of the first rib. The long thoracic nerve is retracted. The lines for cutting the first rib, including a nubbin of the lateral process of the first thoracic vertebra, are indicated. The actual exposure is fully as good as shown here.

retracted forward into the space formerly occupied by scalenus anticus muscle, disclosing the bed of the subclavian arch, the subclavian groove in the first rib. Separate tapes are slipped around each trunk of the brachial plexus and they too are very gently retracted forward. The subclavian groove is fully exposed. (Fig. 4.)

At the superior posterior edge of this groove the rib begins to curve sharply mesially and upward, approaching the transverse process of the first dorsal vertebra. At this point also begins the attachment of the scalenus medius muscle. Because of the mesially directed curve of the rib the scalenus medius attachment to the first rib is nearly at right angles to that of the scalenus anticus. The anterior edges of the trapezius and scalenus posticus, which attaches to the posterior portion of the second rib, are retracted backward, exposing the latero-posterior side of the scalenus medius muscle; the long



thoracic nerve of Bell is located as it runs down the side of the scalenus medius and crosses over the first rib. Whether this nerve is to be avulsed depends upon the opinion of the operator. While the serratus anterior muscle, which this nerve supplies, is not given much credit as a regular muscle of respiration, it is one of the important accessory muscles of respiration and when absolute immobility is desired in the collapse, paralysis of the serratus anterior is an aid. If a large rib resection is to be performed later the costal insertions of this muscle will be destroyed anyway. Very little deformity results from the avulsion of this nerve, particularly in patients who will never be subject to physical labor. A slight clumsiness of the upper extremity is noticed in dogs

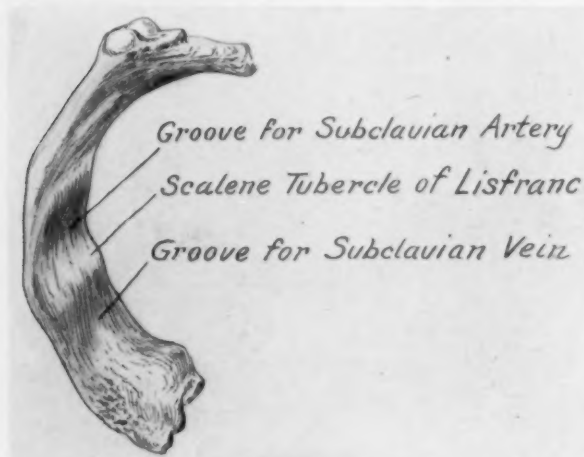


FIG. 6.—The first rib, disarticulated from the costal cartilage and vertebra. The first rib with its cartilage and half of the manubrium forms a semi-hexagon, broken at its divisions into thirds. Its posterior third parallels the lateral plane of the body and bends upward at an angle of approximately 40 degrees.

that have had their long thoracic nerves avulsed. If the nerve is to be avulsed, it is done at this time. If not, the nerve is separated from the muscle and from the first rib where the nerve crosses this rib. Then the scalenus medius muscle is cleanly severed from its attachment to the first rib and the first rib is exposed up to the lateral vertebral process of the first thoracic vertebra. (Fig. 5.)

The pleura, which is adherent only to the upper inner narrow margin of the rib is stripped off gently, and the rib is cleaned on all sides with a rib stripper, little attention being paid as to whether or not the periosteum is cleanly removed. The rib is then cut transversely at the upper inner edge of the subclavian groove and at the transverse process of the first dorsal vertebra removing a small nubbin of the transverse process with it. (Fig. 6.)

The vertebral section of the rib should be made with the points of the cutting instruments pointing downward and backward to prevent possible injury to a low lying vertebral artery. The rib section is removed and the remaining edges are examined and are smoothed off. There is no danger of injuring the spinal accessory nerve in this operation as it runs down the latero-posterior side of the scalenus posticus and is out of the field of the operation.

In this manner an optional one to two inches of the first rib can be removed under direct vision without injury to any structures and the phrenic or long thoracic nerve or both may be avulsed at the same operation. Very little bleeding is encountered, and if any bleeding is present, a gauze drain may be

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inserted. The cut ends of the omohyoid muscle are approximated. The severed portion of the sterno-cleido-mastoid muscle is sewed to its previous attachment, a subcuticular suture is put in and the skin closed.

Marked collapse of the lung takes place immediately, so much, indeed, that it is ample for many apical lesions. The patient has not experienced any degree of shock. If the brachial plexus has been handled, respectfully, it is not injured, and if it has received a mild degree of trauma, this will clear up

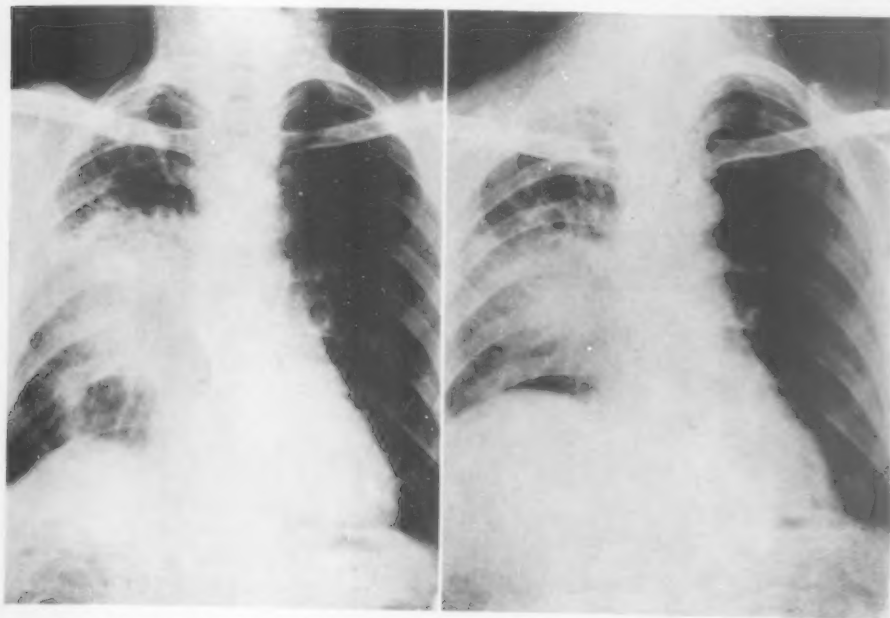


FIG. 7.—Case No. 32,899. a. Röntgenogram before operation showing cavities in the right upper lobe, and fibrosis and bronchiectasis of the middle and lower lobes. Note large areas of pleural adhesion. b. Röntgenogram of the same case eight days after operation showing the marked collapse from above and below. The apex is collapsed down to the clavicle. This amount of collapse is in itself ample for many apical lesions. The diaphragm has been elevated one and a half costal spaces.

in a short time. The patient should be watched for a week to see the extent of collapse that has been obtained, and future operation, if necessary, planned accordingly.

CASE REPORT.—The practical application of this procedure was demonstrated in Case No. 32,899. Mr. D. J. M., a farmer sixty-seven years of age, with a negative family history, who about eight years previous, following a few days of indisposition, from no apparent reason such as operation or the knowledge of the aspiration of a foreign body, suddenly coughed up a large amount of pussy material, termed by him "corruption." This was followed by an acute illness, but in two weeks' time he was feeling fairly well and within a month had resumed work. Being a very stoical individual, he said that he had been well until the presenting illness appeared. His family stated that he had not been real well in the eight years, being but a silhouette of his former robust self and having frequent colds, considerable productive cough and at times a most offensive breath. Two years before the patient had a right hemiplegia and he had never recovered much use of his right arm. About three and a half months previous to his admission he began coughing and raising a thick yellow sputum. He would

improve and regress until one week before seeking relief when he began to feel very miserable with fever and severe cough and inability to sleep at night for coughing, expectorating as much as a teacup full of pus in a night.

When first seen he was a very feeble, sick old man. Physical examination showed occasional moist râles over the right chest with a central upper region over which breath sounds and tactile and vocal fremitus were absent. White blood-cells, 9000; hæmoglobin, 80 per cent.; red blood-cells, 4,090,000. Wassermann negative. There



FIG. 8.—Case No. 32,899. Eight days after operation showing the healed incision and the depression below the clavicle indicating the apical collapse.

were no alarming urinary findings. The röntgenogram showed a large abscess with cavitation in the upper portion of the right lobe with bronchiectasis and much fibrosis. Under the fluoroscope the diaphragm travelled about one-fourth of an inch during respiration and was elevated and nearly fixed. (Fig. 7a.)

The patient and his family were informed of the gravity of his case and were told that little hope was entertained for medical relief, though it should be tried. The patient was hospitalized under rest, tonics, postural drainage and steam. Daily sputum examinations were made. No tuberculosis bacilli or spirillæ were

ever found. Occasionally staphylococci and streptococci and fibrous tissue were present. His highest daily temperature, 102.8 degrees, on admission showed slight change until the abscess broke on the tenth day. Three days later it was normal and did not go above 99 degrees for fourteen days. His leucocyte count increased to 18,000 and remained high. His sputum increased until the abscess broke and then decreased.

After twenty-four days of observation, his general state of well-being was much improved and his temperature was normal, but his leucocyte count was high and the cavity had not diminished in size. Pneumothorax was not possible because of the obvious presence of large fibrous adhesions. Surgical collapse was necessary.

The first stage operation was performed exactly as described above. The phrenic nerve was avulsed because there was still slight movement of the diaphragm. Because the patient had a paraplegia on the right side and very little use of the right arm, the long thoracic nerve was also avulsed to get all possible collapse. (Fig. 7b and Fig. 8.)

Marked collapse was immediately evident from inspection. His temperature, never above 100 degrees, was normal in five days and his sputum was decreased one-half. After eight days the wound was entirely healed, the diaphragm was elevated more than one interspace, and fixed, the apex was dropped as much, there was appreciable lateral collapse, and there was absolute immobility of the right side of the chest.

## THE RESULTS OF OPERATION FOR DUODENAL ULCER IN PHYSICIANS\*

BY DONALD C. BALFOUR, M.D.

OF ROCHESTER, MINN.

THE relative merits of the various operations employed in the surgical treatment of chronic duodenal ulcer continue to be discussed, frequently with a surprising disregard of established facts. It is difficult to explain the great discrepancy in the results of the same operation from different clinics; but the common fault of pointing out only the shortcomings of one operation and emphasizing only the merits of another is in part an explanation of this discrepancy.

My purpose in this paper is to place on record the results of various types of operation performed in the Mayo Clinic on 100 physicians suffering from chronic duodenal ulcer. The average time elapsing since operation is eight and a half years.

This report on the investigations of results in physicians was compiled for several reasons, the two most important of which may be mentioned. First, the cases are well selected, that is, they represent the chronic case in which operation is clearly indicated; a physician with duodenal ulcer usually has tried various forms of medical treatment repeatedly and the frequency of complications is evidence that operative treatment is more likely to be deferred by physicians than by the laymen. For instance, hemorrhage had occurred in 40 per cent. of the cases, whereas in laymen the incidence is only 20 per cent. Obstruction was reported in 32 per cent., whereas in laymen it is 18 per cent. Second, physicians have difficulty in carrying out any post-operative regimen which demands regularity in habits of living and eating. During the period of development of the ulcer and during the post-operative period the physician is unable to protect himself against interruptions in the routine which he would like to follow and which he should follow. The results of surgical treatment under such circumstances should, therefore, be more than a fair test of its value.

The average age of the patients was forty-seven years; the average time since the onset of symptoms was thirteen years. The operations performed were: posterior gastro-enterostomy in 89 per cent., excision alone in 6 per cent., anterior gastro-enterostomy in 3 per cent., and gastroduodenostomy in 2 per cent. (Table I.) These figures show in a rather striking way that the practice in the clinic has been in the past toward conservative operations for duodenal ulcer; and, for the type of duodenal ulcer in which we advise operation, conservative measures are still preferred. Excision alone was usually undertaken for the small duodenal ulcer on the anterior wall, not involving the pylorus, and when the lesion could be excised either with a

\* Read by title before the American Surgical Association, May 14, 1927.

knife or cautery without encroaching on the pylorus. Such simple excisions were also usually rendered advisable by a difficult cholecystectomy or appendectomy or both. Anterior gastro-enterostomy was performed in three cases in two of which entero-anastomosis was added. Gastroduodenostomy was performed in two cases. It must be said, however, that there did not appear to be as frequent indications for plastic operations on the duodenum and

TABLE I.  
*Types of Operation Employed in 100 Cases*

Primary procedure	Cases	Average age, years	Average length of history, years
Posterior gastro-enterostomy . . .	89	46	13
Excision . . . . .	6	43	7.5
Anterior gastro-enterostomy . . .	3	53	21
Gastroduodenostomy . . . . .	2	37	1.5

pylorus ten years ago as at the present time when about 15 per cent. of operations for duodenal ulcer now are excisions and some type of pyloroplasty or partial duodenectomy.

The results of the various operations are summarized in Table II. Complete relief of symptoms is reported in 87 per cent. of the cases in which posterior gastro-enterostomy was performed. The average time since operation in this group is eight and a half years. There were six cases (6.7 per cent.) in which symptoms recurred to some extent, but such symptoms have

TABLE II.  
*Results According to Type of Operation*

	Cases
Anterior gastro-enterostomy . . . . . Complete relief in three cases (100 per cent.)	3
Gastroduodenostomy . . . . . Complete relief in one case (50 per cent.); second operation in one case	2
Excision . . . . . Complete relief in two cases (33 per cent.); incomplete relief in two cases; second operation in one case, and failure in one	6
Posterior gastro-enterostomy . . . . . Complete relief in seventy-eight cases (87.6 per cent.); incomplete relief in four cases; second operation in three cases, and failure in four.	89

been either corrected by subsequent operation or are controlled by care in diet. Of these six patients one expressed the result as a "50 per cent. cure", and two said that they were "greatly relieved". One patient had a hemorrhage three years following gastro-enterostomy; excision of an angiomatous area of the stomach afforded him complete relief of symptoms and complications since that time. In one case a gastrojejunal ulcer which developed was excised,



## DUODENAL ULCER IN PHYSICIANS

the anastomosis was disconnected and a plastic operation was performed on the pylorus. Symptoms, however, persisted and one year later a posterior Polya was performed following which relief has been complete. Five cases in this group (gastro-enterostomy) may be listed as failures. In one a gastrojejunal ulcer recently necessitated operation. In another, recurrence of symptoms has suggested gastrojejunal ulcer; this has not been confirmed by examination since the patient is able to control the symptoms by diet. One patient has had symptoms which he attributes to gall-bladder disease. In one case, in which a large mass found at the pylorus at the time of the first operation was thought to be a duodenal ulcer, the patient returned to the clinic three years afterward with what was considered to be an inoperable cancer of the stomach. If this proves to be correct, the primary lesion was in all probability carcinomatous gastric ulcer rather than duodenal ulcer. One patient reported that he had had no relief whatever since his operation.

If we, therefore, consider the entire group of cases in which gastro-enterostomy was performed, including the two in which operation has been performed subsequently, we find that in 90 per cent. the symptoms are completely relieved, and in 5 per cent. they are greatly relieved; in 5 per cent. symptoms at the present time are sufficiently troublesome to indicate that the operation was a failure, although in three cases the symptoms are apparently due to conditions other than ulcer.

Of the group in which excision was performed results were not as satisfactory. In two of the six cases results were perfect. In one hemorrhage recurred until gastro-enterostomy was performed and symptoms were completely relieved. Two patients reported symptoms suggestive of gall-bladder disease, and one reported his operation as a failure.

Of the group in which gastroduodenostomy was performed a good result was attained in one, and in the other, a second operation was performed (partial gastric exclusion after the method of Devine) with complete relief of symptoms. In the group of three patients in which anterior gastro-enterostomy was performed, combined in two with entero-anastomosis, all the patients reported perfect results without any qualifications.

If the results of these various types of operation are summarized it is found that, in eighty-four of the 100 cases, results can be classified as completely satisfactory. Many physicians have apparently found it a wise precaution to follow a regular habit of living, to avoid over-fatigue and never to indulge in larger meals at longer intervals. One physician said that he was free of his ulcer symptoms but that he exercised care in his diet; he observed, however, that this was no more than any other person would do. Some of the statements by physicians were almost extravagant expressions of appreciation. The good effects of the operation had been reflected, not only in their own health, but in the peace and contentment of the family.

In six of the 100 cases relief has been incomplete. However, in all of these the patients considered that the operation had been worth while, so that in a total of 90 per cent. the operation may be classed as successful.

In five of the 100 cases secondary operation has been performed (Table III), in two for recurring hemorrhage (in one after excision and in one after posterior gastro-enterostomy); in one for reactivation of the ulcer after gastroduodenostomy, and in two for gastrojejunal ulcer. In three of these there has been no return of symptoms or hemorrhage since the operation and

TABLE III.  
*Subsequent Operations*

Primary operation	Reason for second operation	Second operation	Third operation	Final results
Posterior gastro-enterostomy	Gastrojejunal ulcer and recurring duodenal ulcer	Excision for gastrojejunal ulcer; cut off gastro-enterostomy; knife excision of duodenal ulcer four years later	One year later a posterior Polya; partial duodenectomy for gastric ulcer	Excellent.
	Melena and hæmatemesis	Excision of angiomatous area of wall of stomach three years later		Excellent.
	Gastrojejunal ulcer	Excision of ulcer, disconnected gastro-enterostomy; posterior Polya thirteen years later		Relief.
Gastro-duodenostomy	Recurring duodenal ulcer	Partial gastrectomy, exclusion (Devine type) eight years later		Marked improvement.
Cautery excision	Hemorrhage	Gastro-enterostomy (elsewhere)		Almost complete relief.

in one, operation has been performed so recently that a good result can only be anticipated.

Five of the physicians report persistence of symptoms of such a character that the operative treatment must be classified as a complete failure. Two say that the operation has given them no relief, and one patient, as we have already pointed out, considers his symptoms due to gall-bladder disease. In one case a gastrojejunal ulcer is suspected, but it cannot be proved and the patient is able to control symptoms by a strict dietary regimen. In one, inoperable carcinoma of the stomach has been diagnosed.

If we estimate the results from the standpoint of what can be accomplished by a policy of conservative operation for duodenal ulcer followed by a secondary operation if symptoms recur, the present condition of the patients demonstrates that the result of conservative measures is satisfactory in 93 per cent. The source of this information seems to establish the fact that a conservative attitude toward the treatment of duodenal ulcer is sound.

## LATE RESULTS OF OPERATION FOR CARCINOMA OF THE BREAST\*

BY WILLIAM CRAWFORD WHITE, M.D.

OF NEW YORK, N. Y.

IN 1922, a paper was read before this society by the late Dr. Charles H. Peck and the writer on tumors of the breast.<sup>1</sup> In that paper we had some information on the five-year operative results in cancer of the breast. It has seemed to me worth while to extend this period for another five years and to review The Roosevelt Hospital cases for the period January 1, 1912, to December 31, 1921, inclusive.

During this period the usual procedure has been a "radical" operation. This has consisted in the removal of the breast, thoracic portion of the pectoralis major, and adjacent axillary contents. The pectoralis minor has been left *in situ*. Special attention has not been paid to the fascia of the rectus abdominis. The amount of skin removed has been moderate in extent. It has rarely been necessary to graft skin. Dry gangrene of the skin edge has been infrequent. The line of incision has been oblique or transverse. The operator made the incision that seemed best adapted to the particular case. The dissection of the skin more and more followed the suggestion of Sampson Handley to remove a large area of subcutaneous fat, but it never has been as thorough a removal of subcutaneous fat as that practiced by some operators. For that reason I think that the information may be of value as a report on the moderate operation.

It has been felt that cases with supraclavicular node involvement were not operable. We had not adopted the practice of Lee<sup>2</sup> in considering a fulness of the supraclavicular region as sufficient indication of inoperability. Nevertheless there are many cases in this group that would not be operated upon now, for I feel that in the earlier years, cases which were not operable were subjected to the knife. Since we have made a practice of taking röntgenograms of the chest, spine, and pelvis before operation, we have eliminated additional cases, but the röntgenogram does not necessarily discover the early bone metastasis. Within the past year the writer had a negative report before operation, yet six weeks later definite Röntgen evidence of metastases to the pelvic bones was present.

Our early cases made little use of radiation before or after operation. Gradually there has developed an increased use of deep X-ray therapy after operation, with practically none before operation. It has been the policy to operate whenever the diagnosis of breast tumor has been made.

It will be noted that these cases may be considered as a group which has not had much radiation. It is true that many have had extensive use of X-ray and radium after recurrences have been noted, but as any case in this

\* Read before the New York Surgical Society, May 11, 1927.

series, that has had a recurrence has been classified with the dead, the factor of increase in length of life after recurrence under radiation has not entered into these statistics. That can more adequately be discovered in such a clinic as that of the Memorial Hospital.<sup>3</sup>

These patients have been both private and ward. The majority of those followed have been private. In recent years under the improved follow-up system we have found no material difference in the end results than what might be anticipated at the operation. The proportion of private patients

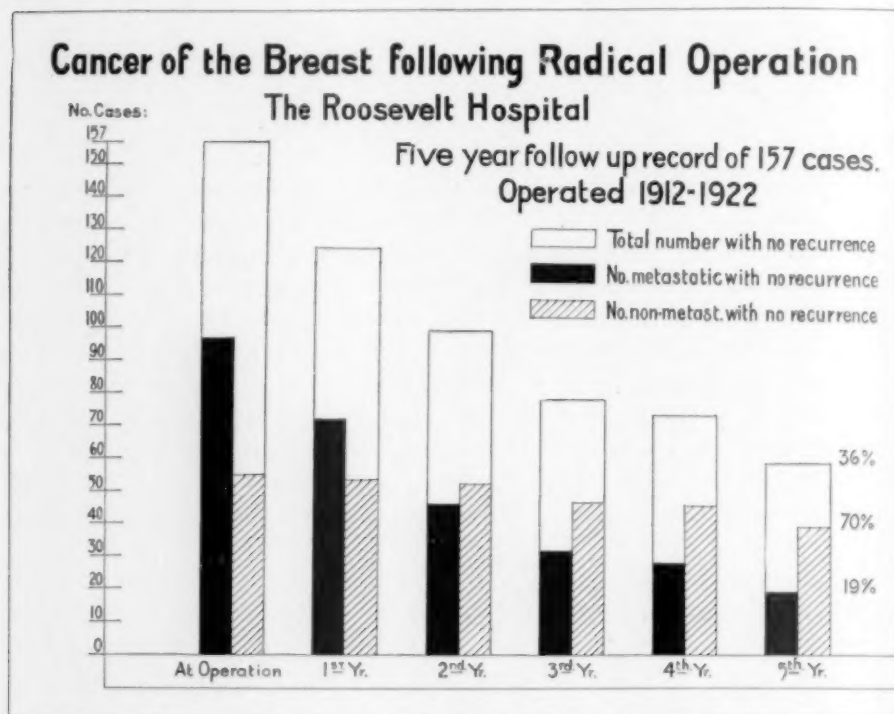


FIG. 1.

without axillary metastases is much greater than in the ward cases. This seems to be due to greater education and knowledge of the potential dangers of tumor in the breast. More and more patients now present themselves for operations on lumps in the breast, which later prove to be benign. Hence the number of early cases of cancer undergoing surgical treatment is increasing.

Local excision with immediate frozen section has been the practice in the doubtful cases. This has not had an appreciable harmful effect, in our judgment, and it has saved many from needless mutilation. It is our confirmed observation that in the early cases it is very often impossible to make a definite diagnosis before local excision. We prefer to tell the patient this. We make a local exploratory excision, with permission to go ahead at the same operation to do a radical procedure, when the frozen section indicates cancer.

The operations have been performed by the attending surgical staff on

## LATE RESULTS OF OPERATIONS FOR BREAST CANCER

duty during this ten-year period. I feel that information gained from such a collection gives a better idea of a good average result than that gathered from the work of one operator. I have been present at most of the operations and have had an opportunity to study the tissue and the microscopic sections. In preparing this paper a reëxamination of the sections has been made and we have excluded a number about which there might be debate as to their malignancy; so I feel that the error of including benign tumors has been reduced to a minimum.

We have late results on 157 cases. There were five operative deaths. At the end of a five-year period 36 per cent. of the 157 were alive and well. I have separated these cases into two groups, those with axillary metastases and those without axillary metastases, after first deducting the operative deaths. Nineteen per cent. of the metastatic cases were alive and well and 70 per cent. of the non-metastatic.

I have made a subdivision to include the five-year period, January 1, 1912, to January 1, 1917. There were 61 cases with 2 operative deaths. We traced the other 59. This group we followed for ten years at least. Ten per cent. of the 40 cases with axillary metastases were alive at the end of ten years; 57 per cent. of the 19 non-metastatic were alive at the end of ten years. This made a total of 59 cases traced with two operative deaths. Fifteen (24 per cent.) of the whole group were alive and free from recurrence at the end of ten years. It is interesting to note from the chart how sharp the rate is at first and then how small the mortality after the first three years.

A number of five-year results after radical operation have been reported.

	Cases	Cures %
Greenough and Simmons <sup>4</sup> (Massachusetts General Hospital).....	69	32
Lee and Cornell <sup>2</sup> (New York Hospital) .....	75	15
Sistrunk and MacCarty <sup>6</sup> (Mayo Clinic) .....	218	36
Moschcowitz, <i>et al.</i> <sup>8</sup> (Mt. Sinai Hospital) .....	89	34
White (The Roosevelt Hospital) .....	157	36

A similar analysis of freedom from recurrence over a five-year period in cases that had no axillary lymph-node metastases has been made by the following:

	Cases	Cures %
Greenough and Simmons <sup>4</sup> (Massachusetts General Hospital).....	16	56
Sistrunk and MacCarty <sup>6</sup> (Mayo Clinic) .....	86	63
White (The Roosevelt Hospital) .....	55	70

I have accurate pathological information as to the site of recurrence in 88 cases. In that group there have been 32 with local or skin recurrence, or 36 per cent. This percentage should not be so high. It is to be remembered that this is the result of not practicing extensive excision of the skin with secondary skin graft. Greenough<sup>4</sup> states that he skin grafts after one-third of his radical operations. This group undoubtedly includes some cases that would now be considered inoperable. In this group there has been a moderate attempt to follow Handley's<sup>8</sup> teachings in regard to the removal of subcu-



taneous fat. It must be remembered that a late skin recurrence (I have noted one as long as sixteen years after operation) may be the result of growth outward from a primary metastasis that had been between the ribs and not removed at the primary operation. Nevertheless I believe that our results teach us that Handley's teachings in regard to the removal of subcutaneous fat should be carefully followed, and that a certain proportion, perhaps not as high as 33 per cent., will require skin graft because of the large mass of removed skin.

Of this group of 88 recurrences, eleven had definite recurrence in the liver

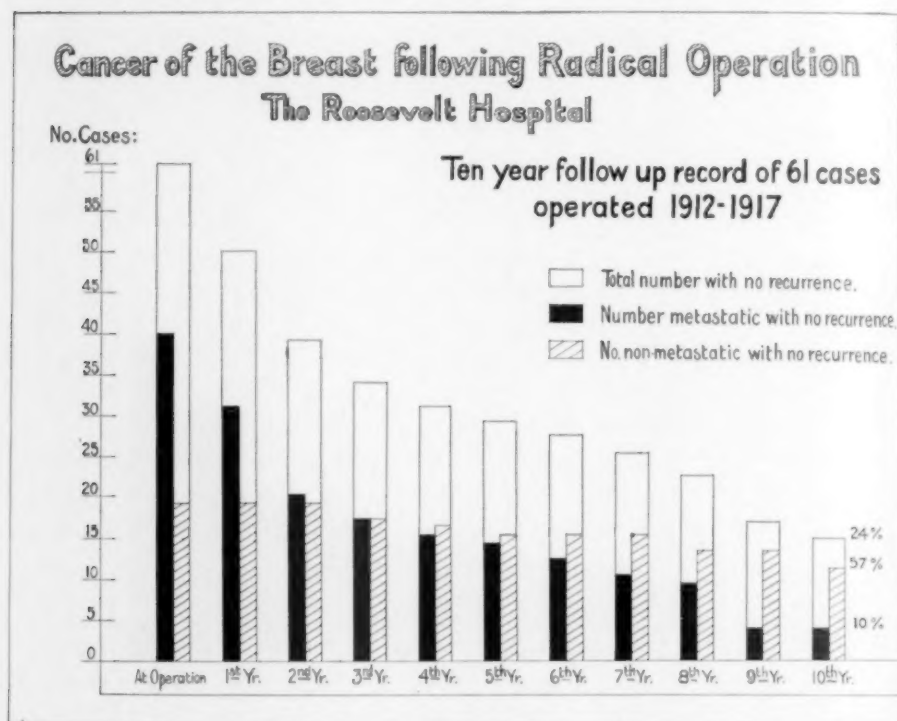


FIG. 2.

or 12½ per cent. This would seem to be rather low when one considers that we did not pay especial attention to an excision of the fascia over the upper end of the recti abdominis.

Sistrunk and MacCarty have suggested that the relative malignancy of the cancer of the breast may be discovered by a study of (a) the cellular differentiation, (b) the lymphocytic infiltration, (c) the fibrosis and (d) the hyalinization. We have not been able to verify their findings in a study of our cases.

A study was made of 100 cases taken here and there from our cabinet. We classified these into one of three groups—low, medium and high malignancy. We followed the description of Dr. Robert Greenough.<sup>7</sup> We find that 69 of our cases were placed in the medium group and we feel that it

## LATE RESULTS OF OPERATIONS FOR BREAST CANCER

makes too large a group, but from a study of the slides we do not see how we could rearrange the group. We feel that more information can be obtained from the two other groups which you will note to be small. In other words, there are definite cases that with Greenough's classification give us considerable information.

### ANALYSIS OF ONE HUNDRED CASES

#### Class I—Low Malignancy

18 cases—14; five-year cures—66%.

	Cases	Cures	Per cent.
A Group (axillary nodes not involved).....	12	11	91
B Group (axillary nodes involved).....	6	3	50

#### Class II—Medium Malignancy

69 cases—33; five-year cures—47%.

	Cases	Cures	Per cent.
A Group (axillary nodes not involved).....	25	22	88
B Group (axillary nodes involved).....	44	11	25

#### Class III—High Malignancy

13 cases—no cures—no per cent.

	Cases	Cures
A Group (axillary nodes not involved).....	2	0
B Group (axillary nodes involved).....	11	0

Greenough<sup>7</sup> analyzed 73 cases and he divided his cases into 19 low malignancy with 68 per cent. cures; 33 medium malignancy with 33 per cent. cures; and 21 high malignancy with no cures. Roughly there is a similarity of our findings to his. In this analysis, I had the help and advice of Dr. Charles W. Lester, our Surgical Pathologist. We discussed and reached agreement on slides on which we had independently made opinions.

### CASES 1912-1917

There were 61 cases with two operative deaths.

59 cases were followed for a ten-year period. Of these, 40 had axillary metastases and 19 had no axillary metastases.

	Total	Meta.	Non-metastatic
Free from recurrence at the end of one year.....	50	31	19
two years .....	39	20	19
three years .....	34	17	17
four years .....	31	15	16
five years .....	29	14	15
six years .....	27	12	15
seven years .....	25	10	15
eight years .....	22	9	13
nine years .....	17	4	13
ten years .....	15	4	11

15 out of 61 cases free from recurrence at the end of ten years—24%.

4 out of 40 metastatic cases—10%.

11 out of 19 cases without axillary metastases free from recurrence at the end of ten years—57%.

Of this group there were in addition 40 lost cases.

# WILLIAM CRAWFORD WHITE

## COMBINED CASES 1912-1922

Total of 157 cases, with five operative deaths.

152 cases followed over five years. Of these 97 had metastases to the axilla and 55 did not have metastases to the axilla.

	Total	Metastatic	Non-metastatic
Free from recurrence at the end of one year.....	125	72	53
two years .....	99	47	52
three years .....	77	31	46
four years .....	73	28	45
five years .....	58	19	39

58 out of 157 cases free from recurrence at the end of five years—36%.

19 out of 97 metastatic cases followed free from recurrence—19%.

39 out of 55 non-metastatic cases free from recurrence at the end of 5 years—70%.

Of this group there were in addition 56 cases which had been lost.

## CONCLUSIONS

The removal of the pectoralis minor does not seem to be an essential part of the operation. While the removal of the fascia over the upper part of the recti is desirable, it is not an important part of the procedure.

A wide excision of the skin is not necessary, but on the other hand, an effort to avoid skin graft at the risk of skin recurrence is poor judgment. A wide skin excision can be partly avoided by the careful subcutaneous fat dissection.

Definite metastases in the supraclavicular region are a contra-indication to operation, as is also large extension to the axilla. A palliative operation may be justified for the mental effect on the patient, but not from the point of increasing length of life. It may also be worth while to prevent the annoyance of a sloughing ulcer.

It is fair to believe that of all operable cases, 30 to 35 per cent. are free from recurrence at the end of five years. If we take only the cases that are free from axillary metastases, 60 to 65 per cent. are free from recurrence at the end of five years.

Our ten-year group of 61 cases indicates that 24 per cent. are free from recurrence at the end of ten years. Of the cases free from axillary metastases about 50 per cent. may expect to be free from recurrence.

A study of the cancer cell in relation to its adenomatous formation, secretion, size variation, nuclear changes and hyperchromatosis gives one a clue as to the relative malignancy of the particular cancer of the breast investigated. It is not as certain as the help derived from a study of the epithelioma of the lip.

I do not believe radiation before operation is proved of value. Radiation after operation has not lowered the mortality in the second half of our ten-year group. Nevertheless I have not abandoned the belief that it may do some good and for the present will continue to advise its use after operation.

I desire to render my thanks to the Attending Surgeons and Staff of The Roosevelt Hospital for their help in preparing this paper.

## LATE RESULTS OF OPERATIONS FOR BREAST CANCER

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## TREATMENT OF CARBUNCLES

A COMPARISON OF FOUR DIFFERENT METHODS

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THE methods for the treatment of carbuncles are legion, which emphasizes the truth that, whether based on scientific principle or on empiricism, the end results are produced by the art rather than by the science of surgery.

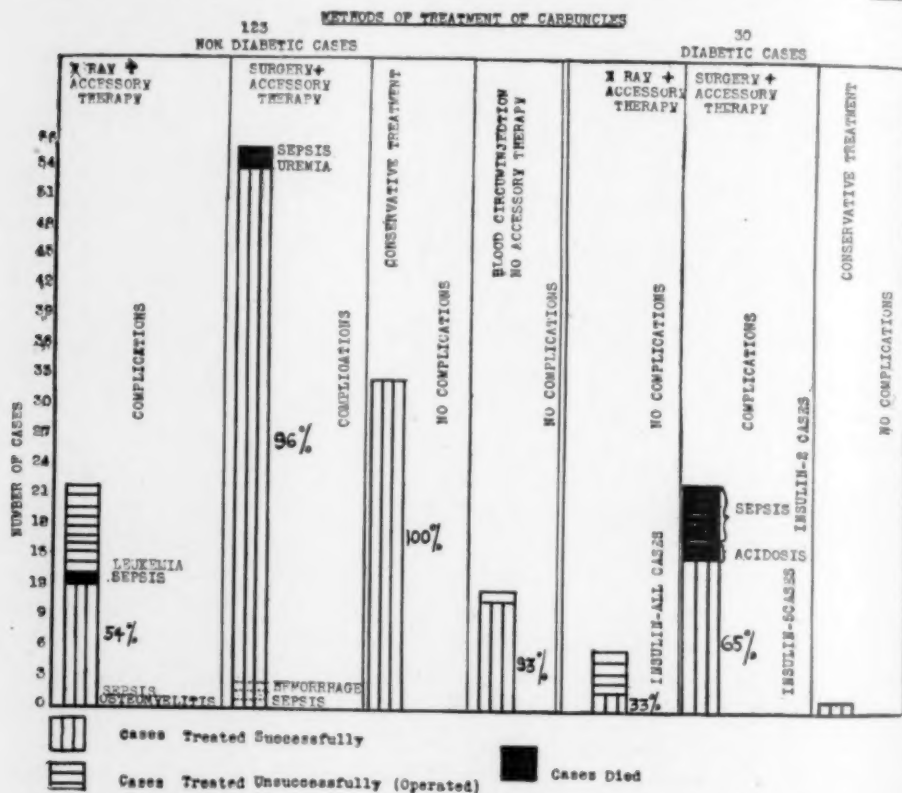


CHART I.—A comparison of four different methods of treatment of carbuncles.

To evaluate these methods is difficult, but any impressions or conclusions derived from recorded facts are worthy of consideration. With this in mind 153 cases of non-diabetic and diabetic carbuncles admitted to the Presbyterian Hospital in the last ten years were studied. Of these only 12 were treated in the out-patient department, and the remainder in the wards.\* Infections

\* There were many other smaller carbuncles treated in the out-patient department which are not included in this series.



## TREATMENT OF CARBUNCLES

of the face severe enough for hospitalization were classed as carbuncles. The four different methods of treatment were: X-ray, surgery, conservative therapy and autogenous blood circuminjection, the last having been discussed in a previous communication.<sup>1</sup>

A comparison of the four types of therapy used necessitates a consideration of the following variable factors, either in treatment or pathology:

1. Dissimilarity of carbuncles. A number of carbuncles of certain size and location, pathological involvement, virulence of organism, and resistance of individual may be treated by one method. It is obviously impossible to duplicate all these conditions for the purpose of comparison with another method of treatment.

2. Lack of definite scheme of tabulation of all the cases. For this reason many important facts and observations are lost which might otherwise prove valuable.

3. Accessory therapeutic measures. This is most important, for enthusiasm for any one particular type of therapy frequently makes one ignore the value of any incidental therapy. When such treatment is given it becomes difficult to tell what produced improvement or cure. Of the four methods of treatment under consideration, circuminjection of autogenous blood was the only one in which accessory therapy was not employed.

The efficacy of any treatment from the standpoint of patient and doctor alike embodies the following factors:

1. Relief from constitutional symptoms. Pain, loss of sleep and appetite, fever, chills, etc., cause the patient primarily to seek medical attention.

2. Avoidance of complications, especially bacterial.

3. The end-result. A minimal scar and good function of the involved area are very important. While a patient may disregard these at the time relief is sought, marked scarring, especially if visible, and loss of function bring complaint later.

4. Anaesthesia. Many dread a general anaesthetic, although direct deleterious effects of a brief anaesthesia are practically negligible, except in those in whom it is especially contra-indicated. Any good method of treatment which produces results without an anaesthetic is to be strongly considered.

5. The time element. This includes the time of hospitalization and the time for complete epithelization and return to duty.

So far as the applicability of a method for the doctor himself is concerned, the following must be considered:

1. The amount of skill required.

2. The practicability for all practitioners with limited facilities.

3. The practicability in large hospitals where every facility is available.

A study of Chart I and Table I will give a general idea of the efficacy of the various types of treatment after substitution of the various factors in the equations shown on page 706.

It is only fair to state that the cases receiving conservative treatment alone were not quite as severe as those receiving X-ray plus accessory

TABLE I.

Location...	Non-Diabetic			Diabetic		
	X-ray <sup>1</sup> —22 cases	Surgery <sup>2</sup> —56 cases	Conservative—33 cases	Blood circuminjection—12 cases	X-ray—6 cases	Surgery—23 cases
	<i>Successful</i> Back of neck, 5 Scapular region, 1 Interscapular region, 1 Upper and lower lip, 1 Nasal region, 1 Upper lip, 1 Lower lip, 1 Sacral region, 1	<i>Successful</i> Back of neck, 27 Upper lip, 7 Lower lip, 7 Sacral region, 3 Occipital region, 2 Scapular region, 2 Buttock, 1 Post femoral region, 1 Zygomatic region, 1 Volar forearm region, 1 Nasal region, 1 Chin, 1 <i>Died</i> Trochanteric, 1 Lumbar, 1	<i>Successful</i> Upper lip, 17 Buccal region, 2 Lower lip, 8 Back neck, 3 Chin, 2 Nasal region, 1	<i>Successful</i> Back of neck, 10 Scapular region, 1  <i>Unsuccessful</i> Back of neck, 1	<i>Successful</i> Back neck, 2  <i>Unsuccessful</i> Back neck, 3 Interscapular region, 1	<i>Successful</i> Back neck, 10 Interscapular, 2 Chin, 1 Sacral, 1 Nasal, 1  <i>Died</i> Back neck, 4 Suprascapular, 1 Interscapular, 1 Temporal, 1 Lumbar, 1
Accessory Therapy <sup>3</sup>	Poultices. Carbolicization. Narcotics. Boric compresses. Dakin's. "Thermolite." Ice compresses. Antiseptics	Poultices. Dakins. Narcotics. Wet dressings. Antiseptics. Ichthyol. X-ray. Carbolicization. Blood circuminjection	The treatment itself equals accessory therapy and consisted in poultices, carbolicization, narcotics, cold compresses, Dakin compresses, ichthyol, "thermolite," ice bag, antiseptics	None. The cases were selected by a committee as spreading carbuncles and only a dry dressing was used	Insulin, (all cases). Poultices. Dakin's. Narcotics. "Thermolite." Ichthyol. Caustic. Autogenous vaccine	Insulin, ( $\frac{1}{2}$ of cases.) Poultices. Narcotics. Dakin's. Antiseptics. Transfusion  Treated with ichthyol and boric acid.
	1. 21 days after X-ray. Tissues involved to ligamentum nuchae 2. 16 days after X-ray. Pus under I flap.	1 case required 3 operations. 3 cases required 2 operations. Extension found			1. 13 days after X-ray 2. 11 days after X-ray	2 cases required 2 operations 1 case required 3 operations

## TREATMENT OF CARBUNCLES

Findings at operation in unsuccessful cases	3, 14 days after X-ray. Extensive necrosis.	4, 12 days after X-ray. Extensive necrosis.	5, 10 days after X-ray. Ligaments of spine involved—area from ext. occipital protuberance to VI cervical vertebra and 4 cm. to each side of midline.	6, 3 and 8 days after X-ray. Extensive necrosis.	7, 7 days after X-ray. Extensive necrosis.	8, 5 days after X-ray. Muscle involved.	9, 3 days after X-ray. Extensive necrosis.	3, 4 days after X-ray.	4, 3 days after X-ray. All had extensive deep necrosis			
Relief pain and constitutional symptoms	±			+++	++			±	++	++	++	++
Complications and death	+			±	-			-	++	++	++	-
Time element	+++			++				++	++	++	++	+
End result, scar function	++			+++	+			±	++	++	++	+

1. As a general rule the following technic was used:  $8\frac{1}{2}$  inch spark gap, 3 mm. of aluminum as a filter, and a dosage of  $\frac{2}{3}$  to  $\frac{3}{4}$  of a skin unit (erythema dose).

2. By surgery is meant radical incision, crucial or multiple, with undermining of flaps and excision of slough in some cases. Fifty-one cases had this treatment and three had excision.

3. This means, as a general rule, a combination of accessory measures. The most frequent combination was poultice, carbolicization, narcotics. The accessory therapy in those patients who had surgery is almost a negligible factor for it is known that in control cases, where just a radical operation with drainage is done, the results are practically the same.

4. The + signs express degree.

therapy. On the other hand, the accessory therapy as a whole was probably more intensive than the conservative treatment. The logical question which then arises is, "What produced the 54 per cent. cure in the first group: X-ray therapy, accessory therapy, or a combination of both?" In the diabetic and non-diabetic cases treated by this method, the extensive spread

Carbuncle + Surgery + Anaesthesia + Accessory therapeutic measures.....	} = $\pm$ Cure {	$\pm$ Complications + Time element + End result
Carbuncle + X-ray - Anaesthesia + Accessory therapeutic measures.....		
Carbuncle + Blood circuminjection + Anaesthesia - Accessory therapeutic measures.....		
Carbuncle + Conservative treatment - Anaesthesia.....		

and tissue involvement will be noted in Table I in those cases considered unsuccessful and operated upon.

Summary.—The difficulty of evaluation of the various methods of treatment in this series must be apparent. Each case is a problem in itself and surgical judgment should be a guide in therapeutic preference. From the facts as noted, the following conclusions are presented for consideration:

1. In large carbuncles, diabetic and non-diabetic, the treatment of choice is radical surgery.
2. In small, superficial carbuncles and in some large carbuncles, including those of the face, X-ray therapy as an aid to conservative therapy (poultices, carbolization, etc.) has given good results. If, however, improvement does not occur in three or four days, other measures (surgery, circuminjection of autogenous blood) are indicated.
3. In diabetic carbuncles prompt establishment of free drainage is essential in order to prevent spread of infection. X-ray therapy without surgery is contraindicated.
4. Circuminjection of autogenous blood may be used in selected cases and it is a valuable adjunct in accessible spreading infections treated by any other method.
5. There has been no proof in the clinical cases analyzed in this series that X-ray therapy alone effected a cure. Reports in the literature seem to confirm this experience.

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## GAUCHER'S DISEASE\*

WITH REPORT OF TWO CASES IN BROTHERS

By HAROLD E. SANTEE, M.D.

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SINCE Gaucher in 1882, originally described this disease which bears his name under the terminology of "Epithelioma primitif de la rate, hypertrophie idiopathique de la rate sans leucémie," numbers of cases have been reported until the present two cases represent about the fiftieth cases. These cases have been the source of much study due to their rarity and interest both clinical and pathological, and more recently to the surgical treatment by splenectomy and its effect on the constitutional condition. In 1926, Cushing and Stout in this country, and Ludwig Pick in Germany reported comprehensively on the cases to date. The latter lists thirty-nine cases of this interesting disease, the American writers by personal communications



FIG. 1.—Photograph showing skin bronzing and conjunctival thickening practically pathognomonic of Gaucher's disease.

and reports bring this number to forty-nine. Whether by careful perusal some of the latter may fall under Pick's secondary classification of "Die lipoidzellige splenohepatomegalie (Tyhus Niemann)" remains in question. I believe that I am conservative in stating from a review of these excellent articles that the disease is one of unknown origin which involves the reticulo-endothelial system pathologically in such a way that on section of specimens from this system we find usually in the order named spleen, liver, bone marrow and lymph-nodes packed with the typical Gaucher cells practically to the point of replacement late in the disease. Clinically we find progressive

\* Presented at New York Surgical Society, May 11, 1927.



enlargement of the spleen and liver, anemia and subicteric tinting of the skin. Bone changes may apparently precede spleen and liver enlargement in some cases, and the presence of wedge-shaped yellowish thickenings in the conjunctivæ are considered almost pathognomonic. That clinical recognition of the disease is much clearer than a conception of its pathogenesis soon becomes evident and leads one to conclude from an investigation of the theories as to pathogenesis that this disease is in familiar terminology neither "fish, flesh nor fowl" and may well fall into that class of diseases like Hodgkins, lympho-



FIG. 1a.—Photograph showing skin bronzing and conjunctival thickening practically Gaucher's disease.

sarcoma, primary endothelioma of lymph-nodes, etc., in which the true differentiation between neoplastic and inflammatory origin is extremely difficult. While the microscopic picture of the Gaucher cells is typical and the absence of lipoidal substance as well as the presence of the cerebrosid kersin apparently in the cell substance has been shown by Lieb and Epstein and confirmed by other workers, nevertheless these advances in knowledge of the disease have thrown no light on etiology nor offered any indication as to the treatment.

Splenectomy has been done in about thirty cases with an operative mortality about 20 per cent. Favorable results have been reported in sixteen cases, and it would seem from these reports that in this condition the average length of life is prolonged by splenectomy, even if the disease is not cured. Weight and strength have increased and anemia and hemorrhagic tendencies have decreased.

CASE I.—Man, C. S., age twenty-nine, single, born in this country, a sheet metal worker and steeple jack, was admitted to Bellevue, Second Surgical Division, on March 24, 1927. He first came under my observation in October, 1926, complaining of a "sprain of the left hip following a jump on a roof eighteen months before." This was followed gradually by increasing disability in the left hip particularly on active use. He had been hospitalized in Brooklyn and rest in bed, suspension and traction by weights, and a walking Thomas had all been tried without effect. In October, he showed on

## GAUCHER'S DISEASE

examination, anemia, a liver three fingers below the costal margin, the spleen I did not feel, although looking for the cause of an anemia, and a left hip which was painful on motion, somewhat tender on direct and indirect pressure, and restricted in both active and passive movement by muscle spasm. Loss of weight had been slight and no fever had been present. X-ray examination of the hip showed "slight irregularity and loss of detail lower half margin head of left femur which is tuberculous in appearance but without extensive bone destruction. Head of femur faintly mottled which may be due to slight rarefaction." The diagnosis seemed relatively clear and I favored the tuberculosis as against an afebrile pyogenic osteoarthritis. Hygienic treatment, arsenic and iron, and variations in splints were used until March, 1927, when he was referred into Bellevue on account of increasing anemia, a sense of discomfort in the left hypochondrium, and increasing bone pathology as evidenced by "rarefaction about the head of the left femur and about the pubic and ischial rami." A blood examination shortly before had shown a negative Wassermann; hemoglobin, 60 per cent.; white blood-cells, 3800; polymorphonuclears, 60 per cent.

On examination at this time, the patient showed an anemia with subicteric tint; a liver which came to the umbilicus; a spleen which could be followed along its anterior border to the pelvis, smooth and hard; peculiar wedge-shaped thickenings of his conjunctivæ rather dark yellowish in color, and a left hip as has been described. The blood examination on March 27, showed white blood-cells, 2700; polymorphonuclears, 57 per cent.; lymphocytes, 43 per cent.; red blood-cells, 2,700,000; hemoglobin, 48 per cent.; no nucleated red cells. The urine was negative for bile and Bence Jones albumin. A gastric analysis showed free HCl to be absent, total 10, no lactic acid. Gastro-intestinal study by X-ray showed a stomach displaced to the right but no intrinsic pathology. Blood chemistry was normal.

After consultation as to the wisdom of splenectomy in Gaucher's disease, the operation was decided upon. On April 4, the patient (Group 1, Jansky) was transfused with 600 c.c. of blood. At this time his icteric index was 19, and a Vanden Berg test was negative both direct and indirect. April 5, splenectomy was performed through a long left rectus incision. The liver was enlarged to the umbilicus, smooth, hard, faintly marked by yellowish lobular markings. A small wedge was excised for examination. The spleen was tremendous, extending from the dome of a pushed up diaphragm to the pelvis and filling the left side of the abdomen. No adhesions or perisplenitis were present, however, and the difficulties of removal were due mainly to the size of the organ and its delivery into the wound. The pedicle was clamped and cut close to the



FIG. 2.—Nodular Gaucher spleen.

hilus. At this time considerable blood was lost from the spleen itself which does not appear in its weight. The whole organ was delivered onto the abdomen except the upper pole, and a clamp through the gastro-splenic omentum freed the organ entirely. With this clamp, a small bullonhole was made in the fundus of the stomach which was repaired with a triple layer of fine chromic catgut. After hæmostasis and review of the wound the abdomen was closed without drainage. A transfusion of 500 c.c. was given.

Following operation, temperature immediately rose to 106 degrees, reaching 107.3 on the second day and signs of pneumonia appeared at the base of the right lung.

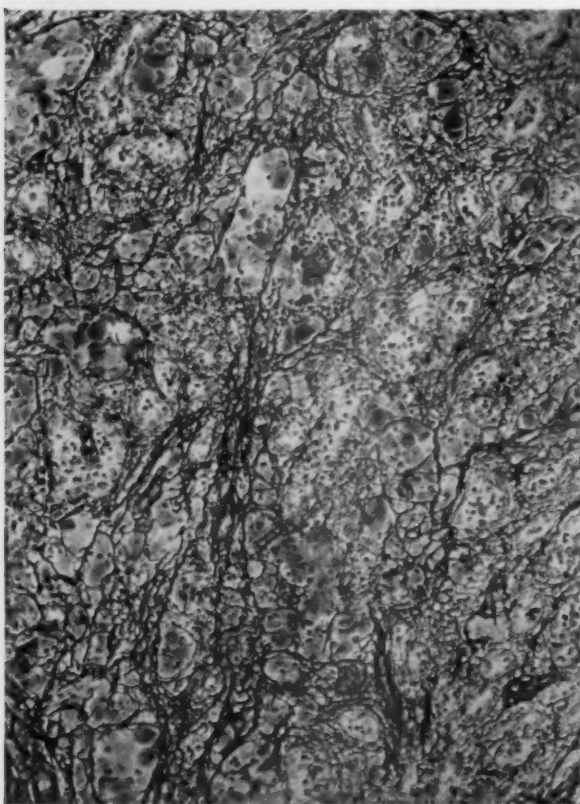


FIG. 2a.—Microphotograph—high power of spleen. Note replacement with Gaucher cells.

This persisted for eight days with a temperature ranging from 103 to 104 degrees, then subsided by lysis in the following eight days. April 7, two days post-operative and at the height of a pneumonic infection, the white blood-cells were 4800; polymorphonuclears, 58 per cent.; hæmoglobin, 55 per cent.

April 9, definite jaundice appeared, and April 12, the icteric index was 72, subsiding to 32, April 14. At this time the Vanden Berg test showed direct—delayed positive, indirect—positive. Convalescence has been slow but progressive since the pneumonia. Wound healing has been slow and infection occurred in the upper wound. April 18 and again May 9, transfusions of 500 c.c. have been given.

The pathological description by Doctor Symmers follows: *Macroscopic examination*: "Specimen consists of an enlarged spleen, weighing

2610 gms. with the blood that escaped from the organ at the time of operation. The spleen measures 29 x 15 x 9 cm. Seen through the capsule, which is perfectly smooth throughout, it presents an irregularly nodular appearance and is brick-dust red in color. On section, the organ cuts readily and the substance of the spleen is found to be riddled with rounded or oval, fairly sharply circumscribed nodules which are distinctly elevated above the surface, many of them discrete, some of them so closely packed as to give the appearance of confluent bodies. These tumors, as far as the naked eye is concerned, vary in size from a few mm. to about 2 or 2½ cm., although in one place there is a tumor which measures 3½ cm. in diameter. Most of the smaller tumors are reddish in color; the larger ones, however, present scattered over their cut surface numerous whitish or yellowish streaks. The large tumor just referred to presents a central area, stellate in outline, firm in consistence, whitish or cream colored, which is obviously composed of fibrous tissue. The rest of this large nodule presents the same naked eye appearance as those already

## GAUCHER'S DISEASE

referred to. The substance of the spleen between the nodules is rather leathery in consistence and scattered through it are myriads of pinpoint sized or slightly larger, whitish or faintly cream colored, glistening specks. In addition, the substance of the spleen presents equal numbers of rounded, sharply circumscribed, slightly elevated, glistening, faintly reddish bodies. Many of the latter, however, on being viewed through a magnifying glass, present a central whitish or cream colored glistening area with a reddish halo, the whitish areas being not unlike those without any evidence of a halo of red at the periphery.

Local application of iodine is negative, except for the fact that the peculiar color it lends to the spleen tends to accentuate the elevated condition of the small whitish or reddish or white bodies found scattered so richly through the substance of the spleen. The splenic substance between those bodies and between the tumor nodules, viewed through a magnifying glass, appears to be swollen, with a pinkish background and a distinct whitish or cream colored tint to it. The larger tumors shell out rather easily.

*Microscopic examination* shows the typical histology of Gaucher's Disease; that is to say, the splenic substance shows innumerable focal and streak-like collections of very large rounded cells with smooth, hyaline, faintly pinkish staining cytoplasm and a small nucleus, and an occasional giant cell with multiple individual or lobulated nuclei and the same sort of cytoplasm. Here and there are massively dilated blood sinuses, many of them completely or almost completely filled by cells of the sort just described. The follicles are still present, but most of them are atrophied. Many of them are surrounded by a definite halo of red blood corpuscles.

In connection with the histology, it is interesting to note that, although numbers of splenic blood sinuses were choked with the large cells which characterize the histology of Gaucher's disease, careful search of the blood during life failed to reveal them in the peripheral circulation. Also, it is to be noted that in Gaucher's disease the lymph follicles are always eventually squeezed out of existence by the characteristic large round cells. In the present case, many of the follicles remain, although atrophic. This finding

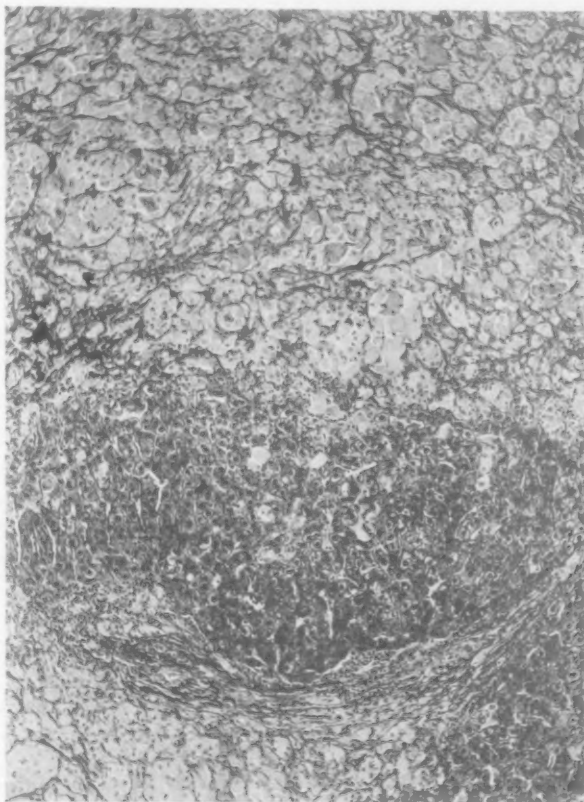


FIG. 3.—Microphotograph—high power—of liver, from small wedge incised from anterior surface near inferior margin. Note replacement with Gaucher cells.



would appear to indicate, it seems to me, that the disease is not of very long standing,

Finally, it is to be noted, that, of the forty cases of Gaucher's disease to be found in the literature, the spleen in every one of them was described as perfectly smooth. The present case, as far as I can learn, is the only known example of a nodular spleen occurring in Gaucher's disease.

Microscopic examination of small portion of the liver removed at the time of operation shows the presence of extensive infiltration of cells of

precisely the same sort as those described in the spleen, the infiltration taking place to such an extent as almost completely to replace the liver tissue."

Since the above pathological report I find that Ludwig Pick in 1926 reported one similar nodular spleen although the nodules were few in number and seemed more fibrotic in pathology than in the above spleen.

CASE II.—M. S., age thirty-one, married, a stenographer, born in this country, is a brother of

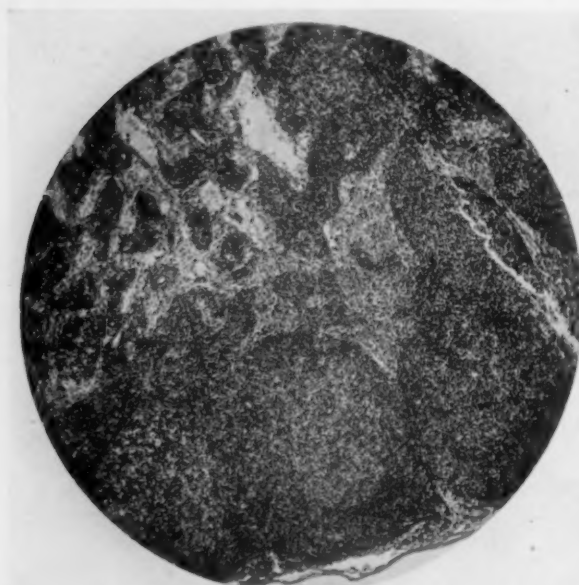


FIG. 4.—Microphotograph—low power—of lymph-node at hilus of spleen.

case number one. In tracing the family history from number one, we found that in a family of seven children with parents living, only this one brother was having any symptoms for which a physician was being consulted and that this brother was under observation for a "big liver". His history apparently dates back to 1917 when he was with the Mexican border troops. Several attacks of epistaxis and bleeding from the mouth brought him under observation at this time. He thinks a diagnosis of "malaria" (spleen?) was made. In hospital later, an enlarged liver was made out and periodically since that time he has been under observation for this liver. The hemorrhagic signs ceased but for the past three years, this patient has noticed a gradually increasing anæmia with shortness of breath and asthenia, some "indigestion" and a constant feeling of pain and discomfort in the right lower chest and upper abdomen. Tonics and rest periodically have ameliorated the subjective symptoms but to the patient himself, they are gradually increasing. At no time have bone and joint pains been present.

Physical examination shows a pale anæmic man of slight build with conjunctival thickening as described by Brill. No icteric tint is present. Abdominal examination shows a liver that percusses dull from the fourth space above to the level of the umbilicus below where its firm sharp inferior margin may be easily felt passing from here across the mid-epigastrium. The spleen may be felt on deep inspiration at a



## GAUCHER'S DISEASE

similar level but is in no way comparable to his brother's in size. The blood picture shows hæmoglobin, 60 per cent.; white blood-cells, 5200; polymorphonuclears, 58 per cent. While the above picture on a single examination is not absolutely conclusive, I think you will agree with me in the diagnosis of Gaucher's disease in this case. After watching his brother, this patient rather desires splenectomy, but thus far I have not felt justified in advising it.

### COMMENT

The above two cases have been a cause of considerable thoughtful consideration on my part. Here apparently we have a disease of the reticulo-endothelial system varying quite markedly in its manifestations—one brother marked by chronicity (ten years), increasing anemia, and symptoms referable mostly to his liver. The other brother is marked by less chronicity (two years), obvious bone changes, and pain and discomfort referable mainly to the spleen, although liver is markedly enlarged. Reasoning by analogy, can splenectomy be justified in the second case on the grounds of relief to the damaged liver as in splenectomy in cirrhosis; as possible relief in a



FIG. 5.—X-ray—note rarefaction lower part of head of left femur and in pubic and ischial rami.

marked secondary anemia; or as a mechanical removal of a heavy painful pressure producing organ? Certainly no one expects to cure a diffuse disease of the character of Gaucher's by removal of a single involved element. Relief of major symptoms, however, seems indicated even if it involves a very major operation and with the possibility of indirect beneficial results such as relief to a damaged liver and some benefit to the anemia, splenectomy seems to be justified although too few such cases have been recorded to warrant definite conclusions. Variations in the type and course of the disease as shown in the above two cases may be the determining factor in advising for or against operation in any particular case. And the same variations in type and course of the disease must be taken into consideration in evaluating the results of splenectomy.

HAROLD E. SANTEE

*Note September 21, 1927.*—Case number one was seen on September 9, 1927. His change through the summer has been remarkable. He looks well and has gained 20 pounds. His hæmoglobin is 70 per cent.; red blood-cells, 3,460,000; white blood-cells, 8400; and his differential shows polymorphonuclears, 36 per cent.; transitionals, 7 per cent.; lymphocytes, 49 per cent.; basophiles, 1 per cent.; large mononuclears, 7 per cent. He is relieved of the indigestion and sense of weight in the left abdomen. His liver remains as described. His hip shows no apparent change.

## THE PHENOMENA OF EARLY STAGES IN BONE REPAIR

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### INTRODUCTION

IN so large a collection of skeletal material as is to be found in the Hamann Museum of Western Reserve University, there are naturally many specimens illustrating the early stages of regeneration of bone after fracture. It has been our task to examine this material in detail for the observation on a large scale of the phenomena of bone repair. We have asked ourselves the following questions: What are the essential principles common to bone repair in different sites? Do all parts of the fractured surfaces and their immediately adjoining bone take part equally in the repair? What is the time relationship of the occurrence of the several phenomena of bone repair? Does the time relationship vary with the site or with the mammal? What modifications in the structure of repair are entailed by the type of fracture? What evidence is there of the site of origin of the definitive callus?

We are well aware that final answers to many of these questions can only be obtained by undertaking a research upon fractures artificially performed in the laboratory on living animals and by the preparation of specimens from human beings of known clinical history. The accumulation of data of the latter type is an exceedingly slow process. Our evidence here given is the result of fifteen years' patient collection. In by far the greater majority of cases there is to be obtained no history of the fracture from the records of the body as patients who reach hospital after fracture very rarely die. We had hoped that our hospital records would at least give us information regarding fracture of ribs followed by pneumonia and death, but we were disappointed. Those who die soon after fracture nearly always end their existence in Cleveland in doss-houses as human derelicts from pneumonia or delirium tremens.

Experimental work we have felt can be undertaken most profitably after and not before a searching inquiry into the evidence available in just such a survey as we propose to report.

Our work therefore is not to be taken as supplanting but as preparing the way for an experimental study which can, after all, be undertaken only on animals.

The writing of this report is the joint work of both authors who also agree upon the conclusions drawn but in the presentation and consideration of these conclusions the senior author takes full responsibility.

The setting forth of such evidence as we are about to present requires

first of all a searching histological study of bone repair. This study has recently been undertaken by Sullivan and his co-workers at Wisconsin<sup>1</sup> and a brief recital of the results obtained by these investigators forms a fitting introduction to the observations which we have been able to make. Under proper aseptic conditions Sullivan, Bast and Geist made sawcuts on

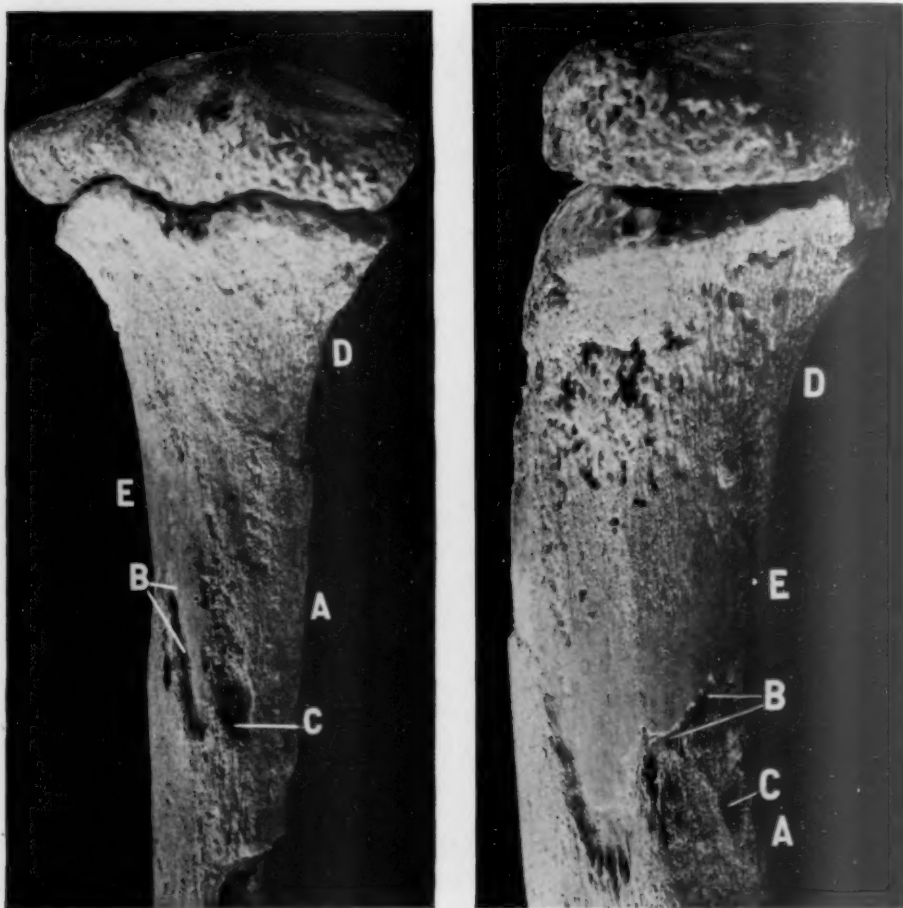


FIG. 1.—Left tibia, White male nine years, E. 16. Osteomyelitis three weeks' duration. Dorsal and lateral views. A. New bone of fourteen days' growth. B. Snail track ulceration of bone, the commencing exfoliation of the upper shaft. C. Nutrient foramen. D. Eroded upper shaft: bone of normal vitality. E. Clean bone of lowered vitality.

the upper tibiae of rabbits of unrecorded age and submitted the bones to histological examination on successive days.

The first day sections show clotted blood filling the cut with giant cells about the bone splinters necessarily produced by the sawing. The external osteogenic periosteum or cambium layer on each side of the cut is thickened by proliferation of its cells. The fibrous periosteum is oedematous. There is no endosteal change apparent.

On the second day masses of fibroblasts begin to organize the clot. The

## EARLY STAGES OF BONE REPAIR

cambium is thickened on each side of the cut for a distance of one-eighth to one-quarter of the bone circumference. Proliferative changes commence in the endosteum.

On the fourth day new bone is present as dentations under the cambium and as long slender coalescing spicules extending into the marrow cavity.

On the fifth day cartilage surrounded by fibroblasts appears external to the cambium. Absorption of cortical bone begins beneath the external callus which itself appears more cancellous than hitherto.

On the sixth day internal callus completely bridges the cut and extends into it.

On the seventh day the external callus is extending into the now more advanced erosions of the cortical bone.

On the eighth day this union of external callus with the eroded cortical bone becomes more intimate and the internal callus shows signs of dissolution.

On the ninth day the external callus has also entered the cut and many osteoclasts are visible in both the external and internal callus.

On the tenth day external and internal callus have joined within the cut.

On the twelfth day the definitive callus has become cancellous, the external and internal callus are reduced in amount and there is more advanced absorption visible of the old bone on the face of the cut.

On the fifteenth day new bone completely fills the cut. There is transformation of the new bone by a process which does not involve the necessary presence of osteoclasts, and embryonic fibroblasts lie over the external callus parallel with the bone surface, indicating the direction of future periosteal fibres.

On the sixteenth day erosion is still marked in the old bone faces and

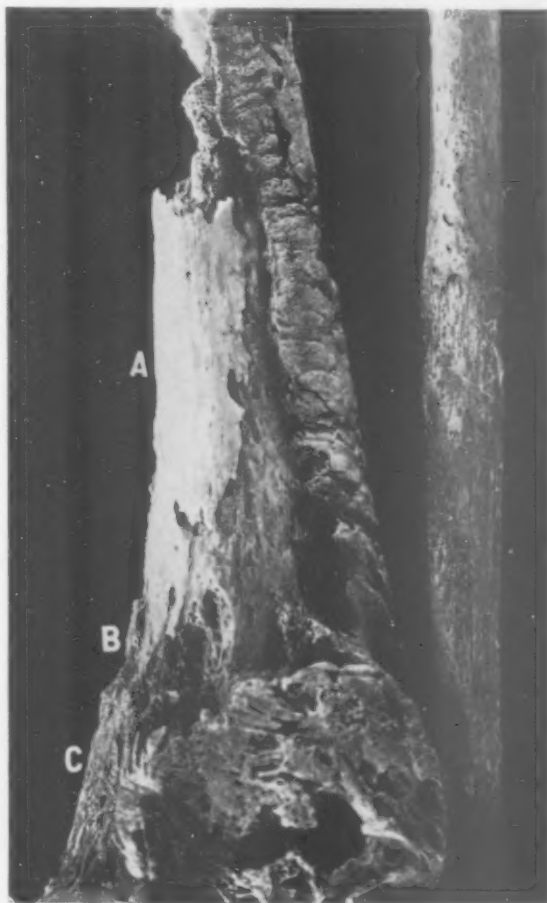


FIG. 2.—Right tibia and fibula chronic osteomyelitis, E. 85. Sequestrum formation. A. Sequestrum delimited by snail track ulceration of bone. B. Site where sequestrum merges with living but unhealthy bone. C. Active but unhealthy bone.



the external callus is much reduced. A line of osteoclasts is observable under the cambium.

On the seventeenth and eighteenth days this excavation of old bone continues and the erosions are rapidly filling with new bone. The new bone is taking the form of Haversian systems.

On the twenty-first day the external callus is entirely removed and even the bone plate in the cut is reduced in thickness.

On the twenty-fourth day the internal callus has almost disappeared.

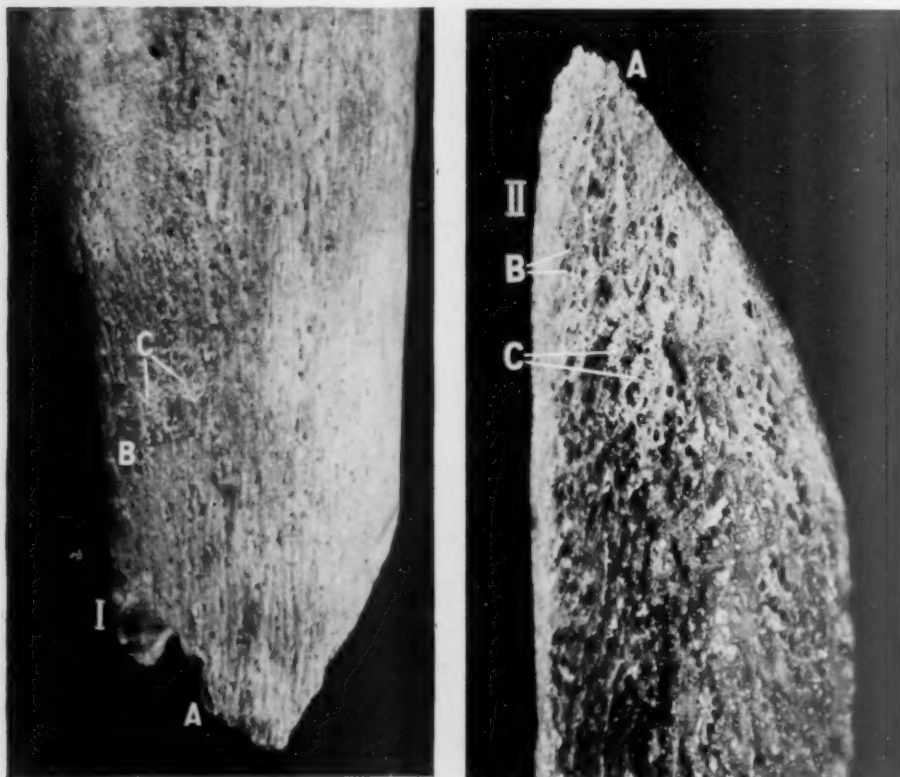


FIG. 3.—Right femur, simple comminuted fracture ca. eleven days. No. 156, male, White, forty-five. *I*. Superficial aspect, upper fragment. *II*. Medullary surface, lower fragment. *A*. Erosion of fractured face. *B*. Vascular erosion. *C*. Early stage of new bone formation.

In this account we observe that the two processes going on side by side in a cut the faces of which are accurately co-adapted—a “fracture” in which there is no mobility of the fragments—are erosion of the cut faces and adjacent bone and proliferation of new bone as callus. There is but little transitional cartilage produced. The source of the definitive callus seems to be the external and internal callus which rapidly disappear after the definitive callus is formed. Callus begins to appear on the fourth day and erosion is obvious by the fifth.

Certain observations are relevant at this stage. First there is probably little if any difference in local mechanical damage to the bone between a

# EARLY STAGES OF BONE REPAIR

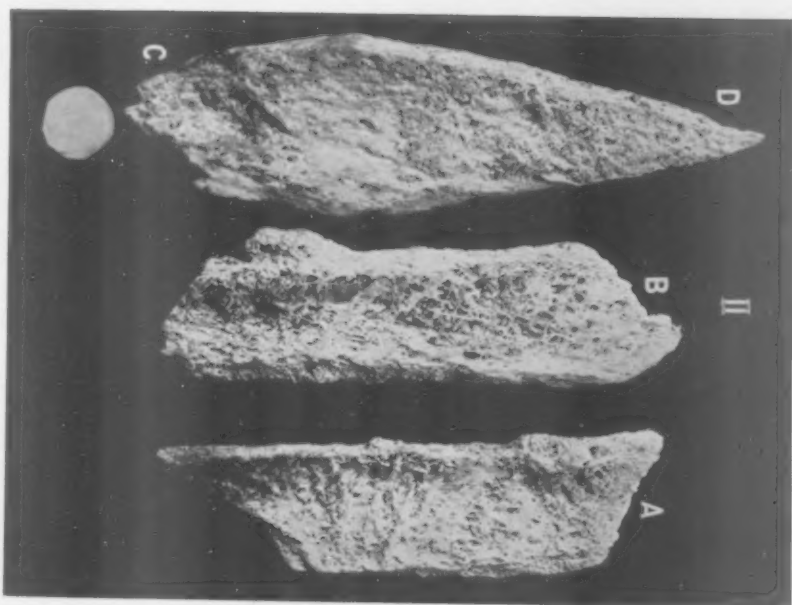
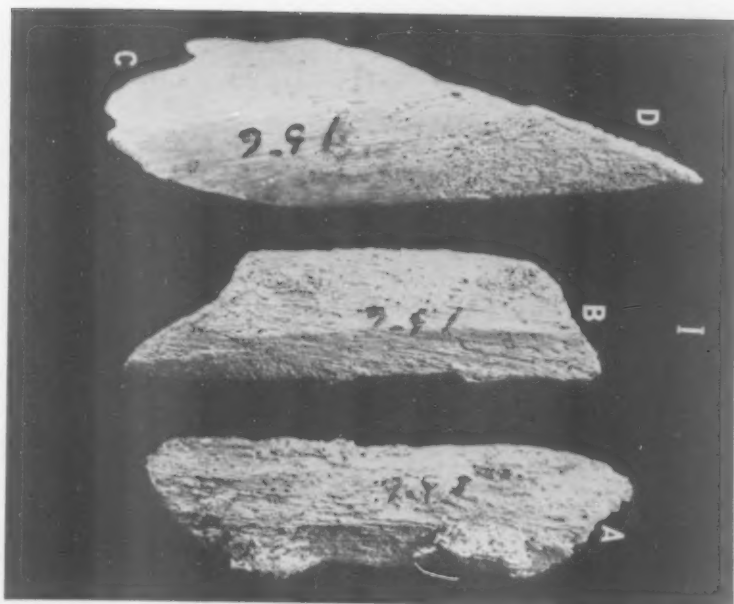


FIG. 4.—Same case as Fig. 3. Comminuted fragments. *I*, Superficial aspect. *II*, Medullary aspect. Pieces *A*, *B* show erosion of edges, vascular erosion, new bone formation. Piece *C*, *D* shows the same at end *D*, but at end *C* it is of diminished vitality, and, although not dead, shows none of these features.

sawcut and a fracture: in both the faces of solution in continuity have undergone a severe mechanical "bruising". Secondly, the early callus would not be visible on a radiogram and would certainly be removed in preparation of the specimen by ordinary maceration or cleaning. It is common experience that callus occurs in sufficient quantity to be apparent in a radiogram between the tenth and fourteenth days. It is also plain that erosion of the

fractured faces cannot be apparent on the radiogram of the living bone since the bony texture is to a certain extent obscured by the soft tissues and the oedema.

*Erosion and New Bone Formation in Osteomyelitis.—*

It is instructive to observe the immediate consequences of a acute osteomyelitis at this juncture.

A white boy, nine years old, suffered an acute attack of osteomyelitis in the upper left tibia which through bad surgery was treated by simple incision of periosteum and, fourteen days later, amputation for pus in the knee-joint. Since the area laid bare by the periosteal incision is well defined and there is new bone formation under the cambium beyond this area we can observe the amount of new bone laid down in fourteen days under the stimulus of acute inflammation. This amounts to 2 mm. in thickness. It is of relatively coarse texture and is channelled by vascular tracks. The very important relation of new bone to new vascularization is not touched upon in the researches of Sullivan, Bast and Geist.

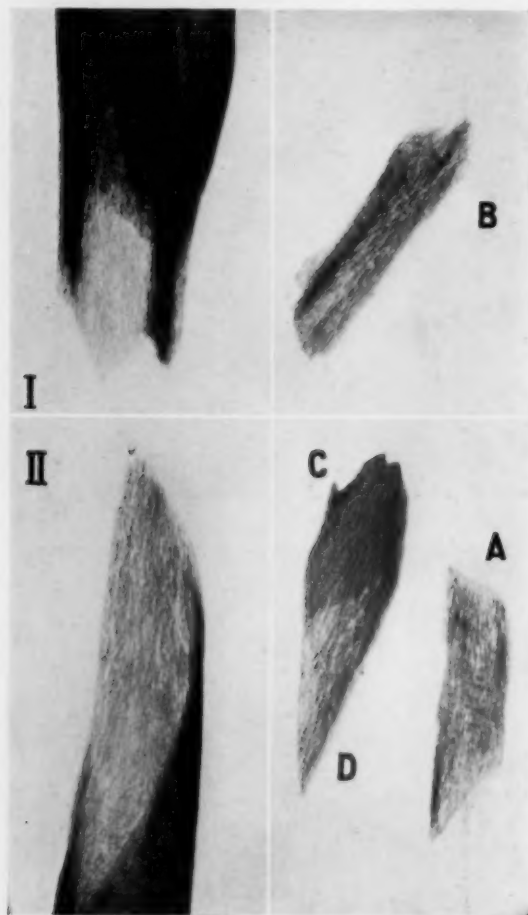


FIG. 5.—Radiograms of No. 156. I. Upper fragment. II. Lower fragment. A, B, C, D comminuted fragments. Note the rarefaction of all areas adjacent to the fracture except C.

In the region of the upper diaphyso-epiphyseal plane the entire substance of the tibia is riddled with erosion and the marks of new vascularity. Delimiting the upper end of the ensheathing callus in the neighborhood of the periosteal incision is a trench-like snail track of erosion, plainly the beginning of separation of the upper tibia as a sequestrum. The bone above this snail track, unlike the upper extremity of the tibia, shows no such riddling with erosion. This is bone in a passive condition. One might surmise, by contrast, that its vascularity is reduced; it is certainly not increased. One could not say it is dead: it is passive certainly, reduced in vitality in all probability and marked for ultimate death. (Fig. 1.)

## EARLY STAGES OF BONE REPAIR

The continuation of the process of separation of sequestrum is familiar in old standing osteomyelitis. (Fig. 2.) But it is not generally recognized that sequestrum separation may be permanently incomplete. In the tibia illustrated in our second figure there is one small area where no solution of continuity has taken place between the living though unhealthy bone and

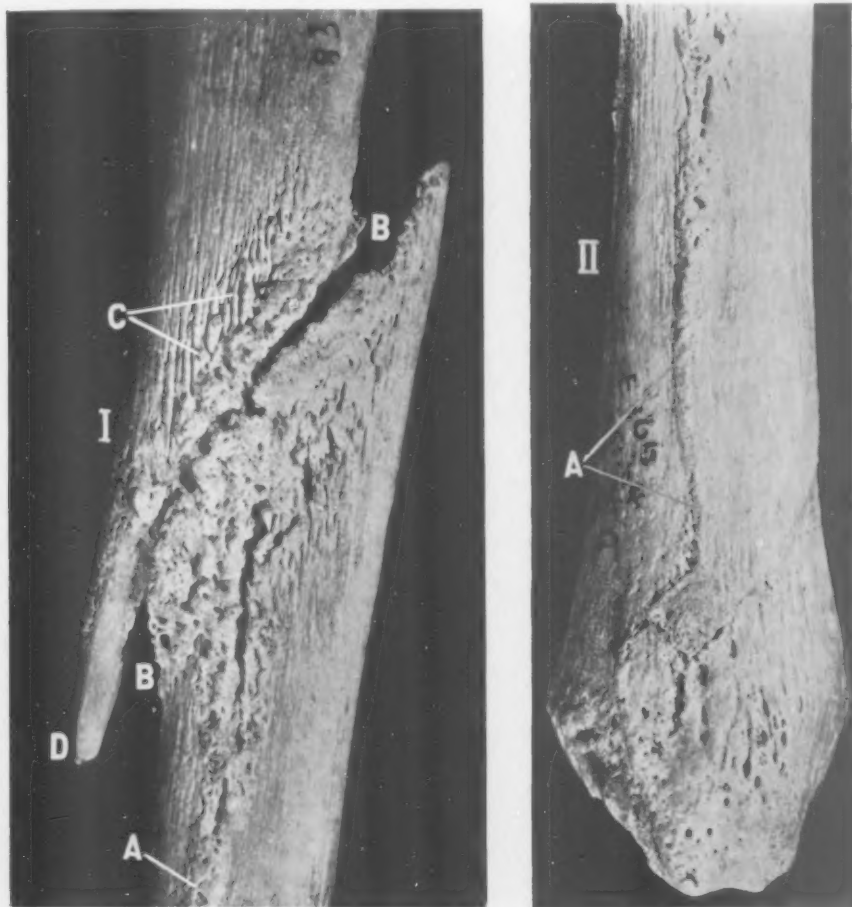


FIG. 6.—Simple oblique fracture with fissured extension left tibia. No. 388, Negro, thirty-eight, ca. seventeen days. I, Oblique fracture. II, Fissured fracture. II, Fissure just below I. A, New bone filling and healing fissure. B, Lava-like callus of oblique fracture. C, Vascular tracks in new bone. D, Area of low vitality.

the devitalized piece. It is difficult to avoid the impression that devitalization is incomplete at this site.

*Vascularity and Erosion in Normal Active Growth of Bone.*—Quite recently the senior author has published an account of the gross features of normal growth of bone in the hard palate and elsewhere.<sup>2</sup> One of the cardinal principles emphasized in that study is the essential exaggerated vascularity of bone which is undergoing growth of active change, illustrated in the palate of the young Chimpanzee. The alveolar process is being much

altered through the change of dentition from milk to permanent and through the development and eruption of the permanent molars. The premaxillary and palate bones are stationary but considerable growth and change are going on in the palatal processes of the maxillæ.

We do not hold that vascularization is directly causal of bone growth or change; we merely insist that bone in such a state of activity requires more

than ordinary nourishment and that enhanced vascularity is the method by which this increased nourishment is obtained. The degree of vascularity may be taken as an indication of the vigor of bone activity. With the vascularity there goes a certain amount of erosion. Channels open up in the old bone for lodgement of vessels, and among the eroded spaces new bone grows up.

The vascular granulations in which is to be found new bone are very readily seen and easily obtainable for further investigation in the healing cavity of a long bone.<sup>3</sup>

There is nothing new in this. The vascularization and erosion of active bone was well known to John Hunter. "Bones, according to Mr. Hunter's doctrine, grow by two processes going on at the same time, and assisting each other; the

arteries bring the supplies to the bone for its increase; the absorbents at the same time are employed in removing portions of the old bone, so as to give to the new the proper form.<sup>4</sup>" Eliminate the idea of the absorbents of lymphatics and we have a concise and accurate statement of what is going on in all bone which is active, whether from the stimulus of growth, repair or inflammation. We ought not to substitute the modern conception of osteoclasts for absorbents, for as frequently recorded (see Bast, Sullivan and Geist above and Macklin<sup>5</sup>) erosion is found in the comparative or even



FIG. 7.—Fractured faces of same oblique fracture. A. Ensheathing. B. Endosteal callus. C. Eroded fracture surface. D. Area of low vitality.



## EARLY STAGES OF BONE REPAIR

total absence of osteoclasts. It would be better, in the light of our present knowledge to say merely that bone is melting away like snow in the sunshine, leaving the discussion of cause out of the problem.

Hunter indeed performed one series of experiments showing conclusively that it is the active living bone which is eroded. "He cauterized portions of bone in the same way in different animals, so as to be able to examine the bones in the different stages of this process, and found that the earthy part of the living bone in contact with the dead portion was first absorbed; afterwards the animal mucilage itself, so as to form a groove between the two, which became deeper and deeper, till the dead bone was entirely detached, the dead portion itself having undergone no change."<sup>4</sup>

Macklin has made a careful study of bone undergoing repair and attributes the erosion to a cell which he finds in large numbers, of varied origin and containing many granules which readily take trypan blue as a vital stain. One of the most striking results of Macklin's study is the demonstration of areas of damaged or devitalized bone by the same vital stain.<sup>5</sup>

There is a very good description by Phemister published some years ago in this Journal,<sup>6</sup> but the author had not the opportunity of consulting a previous detailed histological study of the phenomena of bone destruction and repair. With the majority of his findings, however, we are in complete accord.

It has been held that clot around a fracture organizes in four to five days,<sup>8, 9, 10</sup> that new bone formation can be found on the eighth<sup>10</sup> or tenth<sup>8, 9</sup> day, that fragments are bound together by the thirteenth day<sup>10</sup> and that bone resorption occurs along with repair.<sup>8</sup> These observations differ slightly in time from those of Sullivan,<sup>1</sup> the difference probably being due to the fact that they were made upon complete fractures.

In his war work the senior author noted that erosion on the face of fractures or edges of operative wounds in bones results in the formation of small

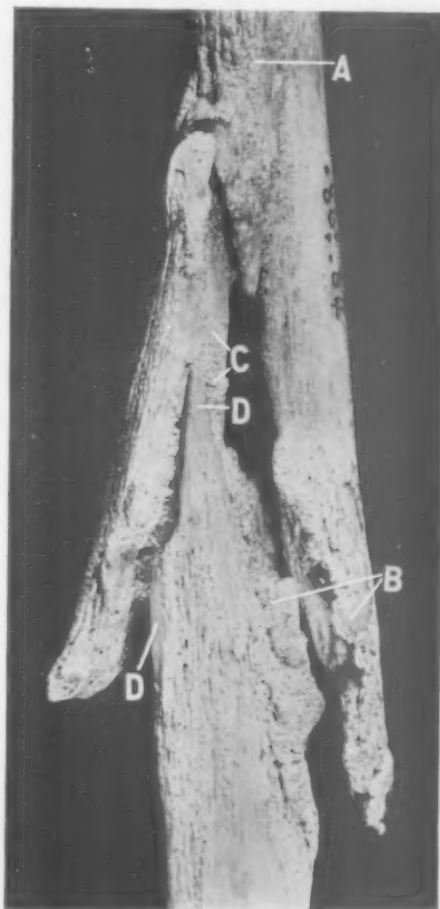


FIG. 8.—Simple comminuted fracture of upper left fibula from same case. A. Healed fracture. B. Ensheathing. C. Endosteal callus. D. Area of low vitality with callus cap into which it fits.

flake-like sequestra which can usually be found within three weeks of the traumatic injury but continue to exfoliate in increasing numbers for six weeks after the injury.<sup>3</sup>

These observations and references lay the foundation for a detailed study of representative specimens illustrating the early stages of bone repair.

*Repair in Long Bones.*—No. 156 is the skeleton of a white male, forty-five years of age. The body of this individual was received from the County Morgue and there is

therefore no clinical history. Death was due to lobar pneumonia. The fracture is obviously recent: by the actual findings discussed below it cannot be more than fourteen days old. Now there is every likelihood of the fracture being the predisposing cause of the pneumonia. Allowing therefore two days for onset of lung complication and nine days for it to reach its height, we are probably not far wrong in citing the case as illustrative of a human femur eleven days after injury.

Now we readily admit that this argument is based upon probabilities which indeed confirm each other but have not, even amassed together, the weight of certainty. And we admit also that it is a simple matter to produce fractures in animals and study the results at definite intervals; we regard this as the next stage, logically, of a scientific investigation of fractures. But we insist, first that this present research is a proper preliminary; secondly, that mammalian bones are not human bones and although details of repair may be perfectly consistent in order and date of appearance, the gross result need not necessarily be precisely the same in such different sized bones as those of dog and man, at precisely the same intervals after injury; and thirdly, that actual recent fractures in human bones are extremely difficult to obtain and that the specimens here recorded form as good a selection as medical science is likely to obtain. We have not slightest hesitation in presenting these bones for serious consideration.



FIG. 9.—Right lower tibia, recently healed fracture. No. 453, male Negro, fifty. Note erratic formation of new bone and large fenestration at bottom of which is a fragment of low vitality A.

The right femur shows a simple comminuted fracture in the middle of the shaft. The edges of the fragments no longer present the clean-cut crystalline appearance of a recent fracture: they are eroded and irregular. In the erosions appear tiny granular masses of new bone. There is as yet only the slightest icing of callus on either external or internal surface. But the fragments of the shaft, for a distance of 110 mm. from the fracture are eroded by large vascular grooves parallel with the long axis of the shaft. From these vascular grooves newly formed foramina perforate the cortical tissue. These are early signs of repair in a bone showing active reaction. Such

## EARLY STAGES OF BONE REPAIR

external callus as there has been removed from the large fragments but endosteal callus which has already reached the stage of cancellous bone is clearly seen on the endosteal aspect (Fig. 3), a stage noted by Bast, Sullivan and Geist on the twelfth day.

In this specimen are three small comminuted fragments on which callus has collected on both surfaces and appears as new cancellous bone. (Fig. 4.) The edges are eroded and upon them also is definitive callus, but there is not yet any attempt at actual union of the fragments which are similar in their appearance to specimens of

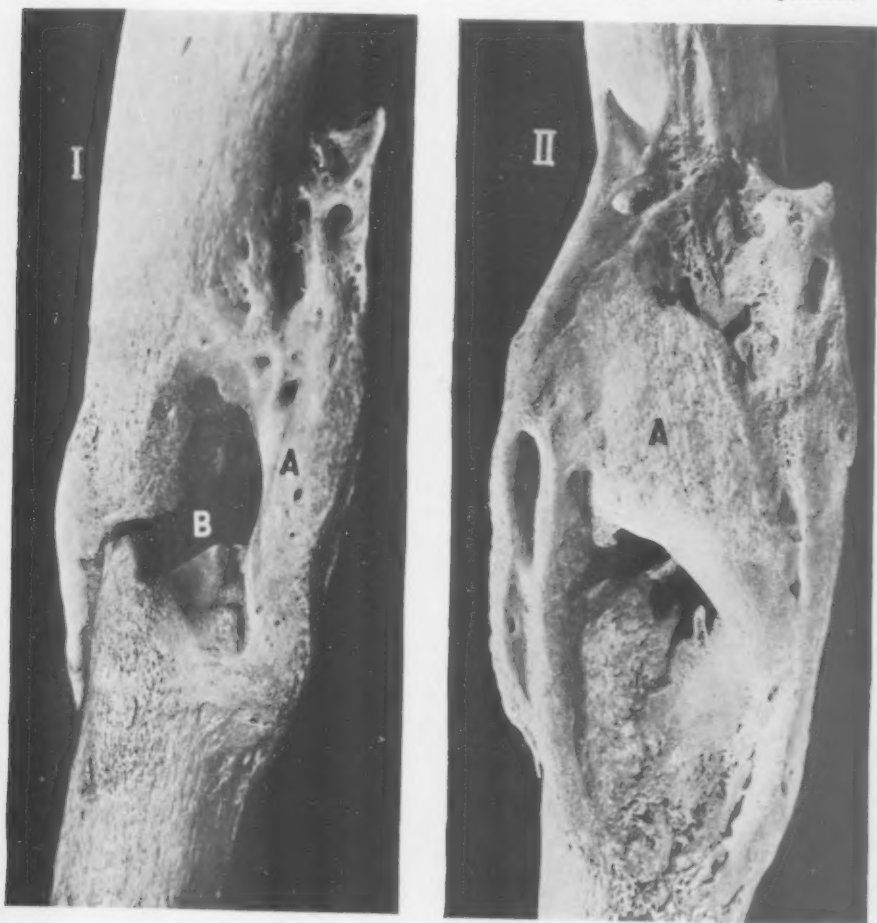


FIG. 10.—Old-standing simple comminuted fracture. Left femur. No. 1380, male, Negro, forty-six. I. Lateral. II. Dorsal aspects. Waxy surface indicates old healed condition with development of compact layer. A. Fragment which has retained vitality and entered into formation of new bone. B. Fragment of low vitality in its fenestration.

Bast, Sullivan and Geist between the tenth and twelfth days after injury. They found erosion under the external callus starting on the fifth day and much more pronounced on the seventh day. The amount present here indicates the passage of several days of activity.

The external surface of the lanceolate fragment C. D. is most instructive for one end alone is eroded. The other end shows neither vascular pits nor grooves: it is marked only by the regular impressions of the normal periosteal vessels and its edges are still crystalline. In the specimen the area is pallid compared with the rosy hue of other areas. This bone is not necessarily dead: it is passive, perhaps

of reduced vitality. We shall show other specimens in which a fragment in this condition becomes an integral part of the new structural bone albeit a passive part. Our first conclusion, however, is that, in a simple fracture, the several areas of fractured bone are not equally active in bringing about repair.

No. 388 is a negro male, thirty-eight years of age, who died of pulmonary tuberculosis and was received, like the last, from the County Morgue. The nature of the illness gives us no real clue to the time the patient lived after injury, but there are

certain indications in the specimen itself. An oblique simple fracture of the left tibia near its middle, is continued downward to the articular surface as a fissured fracture with a spiral upward and backward from the lower end. These accessory extensions of the fracture are filled with a new cancellous callus and the external callus is reduced or absorbed. Bast, Sullivan and Geist describe this phase on the fifteenth and sixteenth days. One would be quite justified in regarding the specimen as seventeen to twenty days after fracture and this fissured fracture is far more comparable with the sawcut of these investigators than the complete fractures which would have presented a practical problem had the patient lived.

Here again we find that the bone is not equally active in repair throughout. This is specially apparent in the illustration of the lower shaft. (Fig. 6.) This variable activity is characteristic of all our recent fractures. It must be understood, however, that inactive areas are not by



FIG. 11.—Ununited fracture lower shaft right humerus. No. 1460, male. White, sixty-one. Note weak reaction characteristic of this age. Erosion feeble. No real callus but some chronic inflammatory new growth.

any means necessarily dead; their vitality doubtless is diminished and they will die and form sequestra more easily than more active areas in appropriate circumstances.

The oblique fracture itself is not yet united (Fig. 6), but the vascular grooves and pits are present leading up to masses of lava-like external callus becoming cancellous. Callus has penetrated but not yet covered the fractured edges. (Fig. 7.) Indeed the edges of the upper fragment are still clean and crystalline. The difference between eroded and crystalline fractured surface is well seen in the over-riding apical ends of the fragments. (Fig. 6.) The lower fragment has a much more active surface than the upper.

### EARLY STAGES OF BONE REPAIR

There is no need to assume delayed union in this fracture. Wherever a complete fracture is associated with an incomplete, greenstick or fissured fracture, the latter heals at an earlier date than the former.

Associated with this tibial fracture is a simple comminuted fracture of the upper third

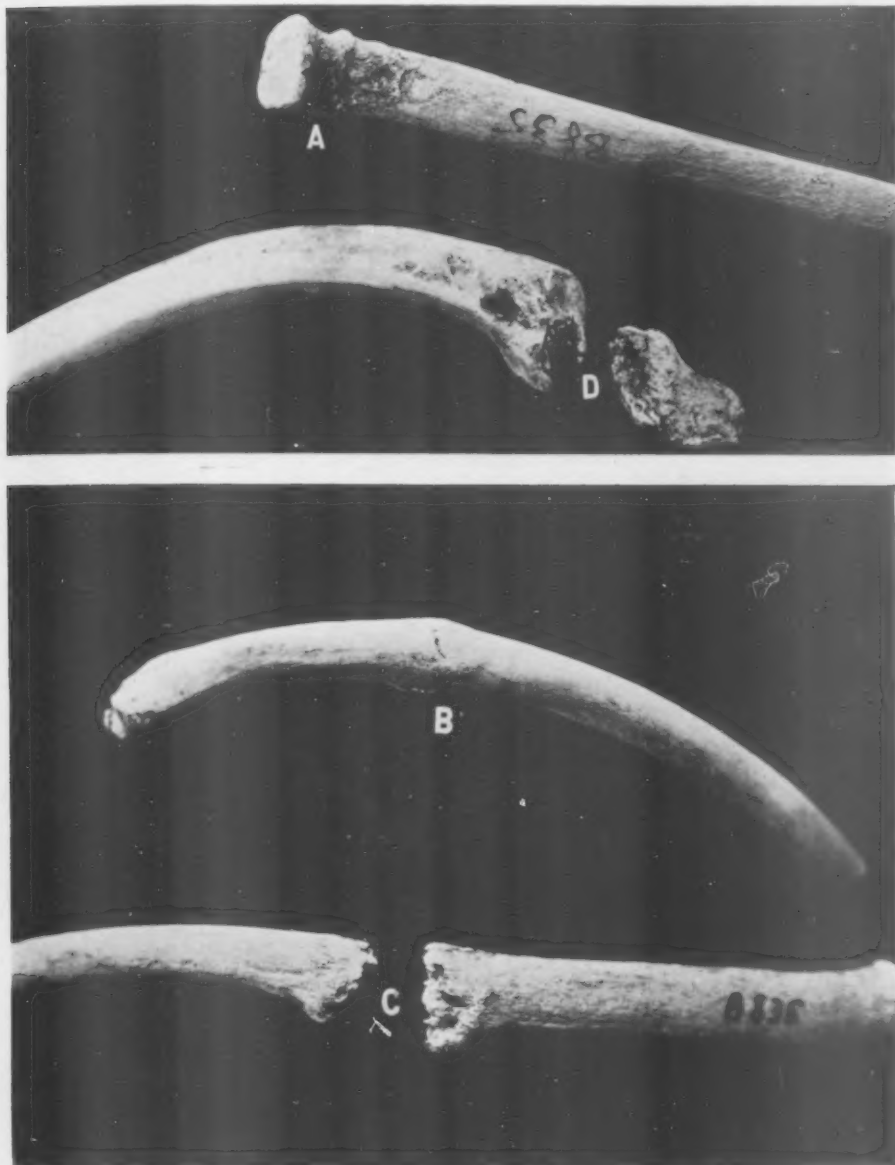


FIG. 12.—Four types of rib fracture from Airedale bitch thirteen days after injury (B. 835). A. Buckling of left twelfth rib. B. Greenstick fracture of right thirteenth rib. C. Complete interlocked fracture of left seventh rib. D. Complete mobile fracture left ninth rib. For characteristics see text.

of the left fibula. In general the phase of repair of this bone is identical with that of the tibia, but some features are much better marked. The cancellous nature of endosteal callus is even more strikingly developed than the cancellous transformation of the massive lava-like tibial callus. Relative inactivity of some areas of the fragments is beautifully



demonstrated. (Fig. 8.) The partial fracture in the upper fragment is already healed. Most of the fractured edges are clothed with callus, but on the lower fragment are three areas totally inactive and appearing as more pallid glistening projections, each of which fits into its cap of cancellous new bone on another fragment. We think that quite probably, had the patient lived, these areas would not have died but would have become ensnared by and embedded in the new structural bone; they would, however, contribute to it nothing more than their bulk and strength, not life or power to initiate new growth, for of the former they had little and of the latter none at all.

No. 453 is a recently healed simple oblique comminuted fracture of the lower right tibia in a male negro, aged fifty years. Again there is no information giving a clue

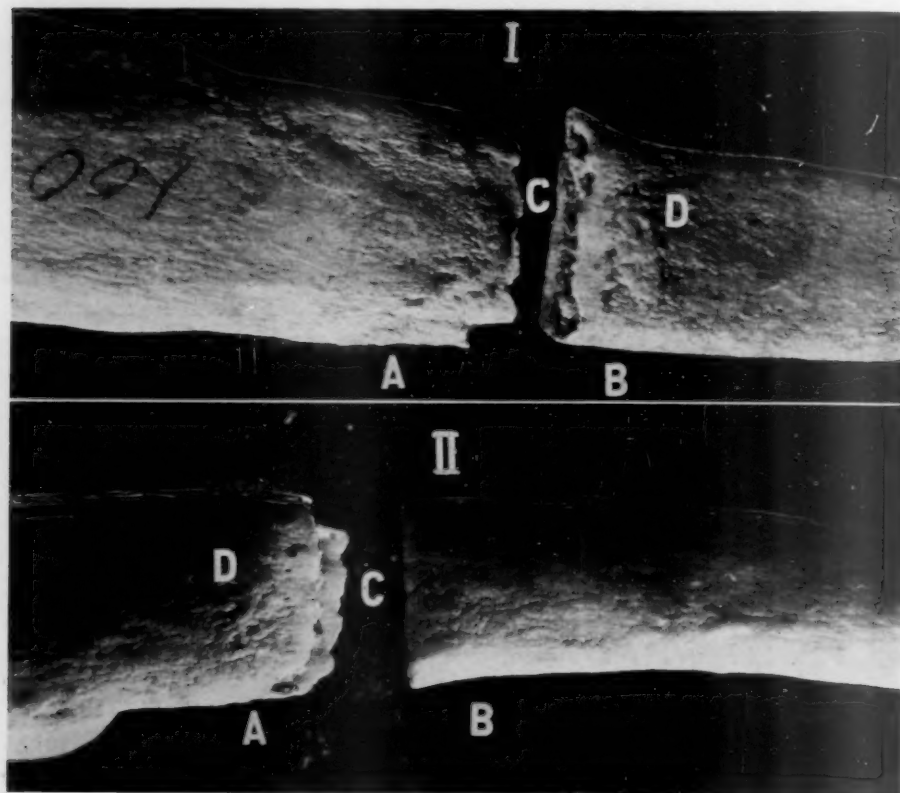


FIG. 13.—Right fifth rib: recent fracture. No. 1007, White, male, sixty-one, I. Deep, II. Superficial aspect of rib. A. Dorsal. B. Ventral segment of rib. C. Bare eburnated fragments of low vitality. D. Weak effort at vascular erosion and ensheathing callus.

to the elapse of time since the fracture, but the cancellous appearance of the callus indicates that healing had not been complete for many months. The erratic nature of the healing process is quite definite. (Fig. 9.) At the bottom of the largest hiatus is to be seen the smooth inactive end of one fragment of the shaft which nevertheless is embedded in and forms part of the rebuilt bone: it is not dead but passive.

No. 1380 is an old simple comminuted fracture of the left femur in its middle third from a negro male of forty-six years. The two main fragments are solidly united by fenestrated plates and bridges of new bone. There is no over-riding of fragments. The uniting callus has now taken on a waxy appearance in marked contrast to the cancellous texture of No. 453. This waxy surface texture is characteristic of long stationary callus. (Fig. 10.) Again the fenestrated character of the union is

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apparent, obviously due to inequalities in repair ability of the several areas. At the lower end of the large fenestration is a cuboidal piece of inactive but yet living bone, a comminuted fragment which has become incorporated in the new structural bone, much as a rock may lie in concrete. Again this piece is not dead; doubtless it had had years during which it might have become a sequestrum but it remained alive embedded as a non-coöperating mass in the newer bone.

A very different fate has befallen the similar comminuted fragment on the back of the shaft. This never had its vitality diminished; it took an active part in throwing out new bone and by its own activity has formed an essential part of the newer built structure.

No. 1460, the right humerus of a white male, aged sixty-one years, presents an ununited fracture of the lower shaft which was in very poor position. (Fig. 11.) The

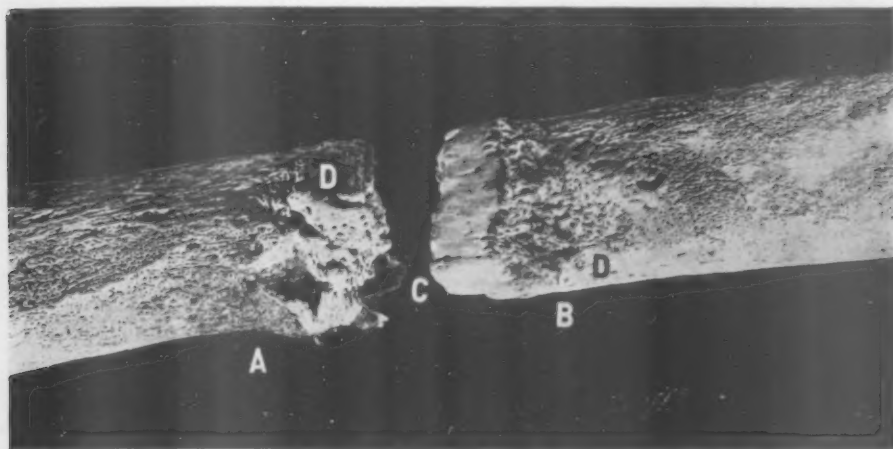


FIG. 14.—Right eighth rib: recent fracture. No. 1173, Negro, male, forty. A. Dorsal. B. Ventral segment of rib. C. Bare eburnated fragments of low vitality. D. Pronounced vascular erosion and ensheathing callus with vascular channels in new subperiosteal bone.

bone is instructive because, although there is erosion of the actual fractured edges, there is no real attempt at repair. There is no erosion, vascularization or pitting of the fragments, no throwing out of new bone as callus, but merely a feeble development of new bone of which the waxy surface bespeaks its age, the result of traumatic inflammation. It bears no evidence of the purposive character of callus.

Probably failure to develop the phenomena of repair is related to the patient's age. A marked change in texture takes place in the skeleton during the fifties, starting in ribs or vertebræ and progressing thence throughout all bones.

We cannot close this account of the early phenomena of repair in long bones without referring to one strikingly successful repair after the use of Lane's plates. No. 973 is a white male of twenty-eight years. The illustration shows the even and complete union of fragments of radius and ulna. The screws remain tightly embedded in bone substance.<sup>7</sup>

So far then we learn that the early characteristics of bone repair are erosion of the fragmented edges, erosion and vascularization of the fragments themselves and an irregularity about the appearance of these features, the fractured areas being of unequal vitality.

We have seen that callus develops on outer or subcambial surface, on inner

or endosteal surface and on the actual faces of the fracture, that this callus develops at the same time as erosion is occurring, that it is first lava-like, next cancellous and much later of a waxy surface texture.

Lastly, we have seen that immobile fractures, greenstick, fissured, or spiral incomplete fractures may unite vigorously and quickly in spite of their immobility, whereas mobile fractures always take longer to unite and may never unite at all, an unfortunate termination more liable to occur if there is deficiency of the substance which controls new bone development. When we rub



FIG. 15.—Recent comminuted fracture right parietal area. *Cercopithecus* sp. B. 1042. In this and the following figures note the unequal vitality of fractured faces; the erosion and vascularization concomitant with repair; the sprung coronal suture which shows no evidence of repair; commencing repair in fissure parallel to left coronal suture; and the vascularity indicative of repair in the left inferior speno-temporal suture.

the ends of a fractured bone together the edges probably do not throw out new osteoblasts, although perhaps more callus is developed roundabout as the result of traumatic inflammation. For a more precise understanding of the effect of rubbing together the fractured surfaces we should consult the ensuing pages on ribs.

*Repair in Ribs.*—Four types of fracture are well illustrated by the ribs, two of incomplete solution of continuity, namely buckling and greenstick and two of complete break, namely of limited and of great mobility. All these types may be found after a single accident and we describe them from a pure-bred Airedale bitch eleven months old (B835), thirteen days after injury. (Fig. 12.)

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The simplest fracture is a mere buckling of the bone shown in the left twelfth rib 8 mm. from the costo-chondral junction. The acute angle of the bend is on the deep surface, but there is no break in the compact bone on either aspect. The superficial surface of the rib shows some increased vascularity with its accompanying and preceding erosion: the deep surface is still stained by hemorrhage and there is a small amount of external callus laid down in the angle of bent rib. Rather striking is the fact, confirmed in other specimens of our collection, that there is more callus formation at the lower edge of the rib near the intercostal artery than at the upper edge. It is true that this may be a coincidence of somewhat frequent but not necessary occurrence.



FIG. 16.—View of vertex of same skull. Note sprung condition of coronal suture with no evidence of repair. Other parts of the skull show considerable though erratic callus.

The right thirteenth rib illustrates well the features of a thirteen-day-old greenstick fracture near the middle of its length. There was a small break in the cortex on the superficial aspect and the fractured edges show no great attempt at repair. Apparently these are areas of impaired vitality for no erosion, vascularity or external callus characterizes the adjacent bone. Upper and lower rib margins, on the contrary, show a small amount of fine textured external callus, that on the lower margin being the greater in amount and extent. On its deep aspect the rib cortex presents the typical vascularity of repair and there is a good deal of fine textured external callus. One can hardly avoid the conclusion that fine texture of callus is associated with immobility.

The left seventh rib is completely fractured 50 mm. from its costo-chondral junction. Thirteen days give too little time for union but active repair is in process. The greatly eroded edges of the fragments are surrounded within and without by masses of callus, the entire cancellous tissue of the rib medulla being transformed. Neither this internal callus nor the external callus has yet united across the gap, but the projecting spicules of the eroded fragments have interlocked and inhibited movement at the fracture line. The steadiness of position of the fragments in this fracture must certainly be held responsible for the widespread and vigorous repair process, not because steadiness of

a fragment is essential but rather because nothing interferes with local repair like rubbing of one fragment on another. This seems a daring thing to say in view of the common practice of rubbing together the fragments of an ununited fracture to stimulate union. The probable rôle of this manipulation is to cause mechanical irritation and so stimulate new bone formation in adjacent areas, the fragmented edges themselves being already so reduced in vitality that no real local effort at repair is possible. As one would expect, the external callus is most abundant on deep aspect and lower border.

In the left ninth rib is also a complete and as yet ununited fracture, but this differs in one essential feature from the last mentioned. Although it has taken place through



FIG. 17.—Left lateral view of same skull. Note the healing fissure extending downwards parallel with coronal suture.

the neck of the rib, there has been somewhat free mobility. There is no lack of external callus and the entire medullary part of the rib is filled with internal callus. These, of course, have not had time to unite across the gap. The old cortical bone is generously vascularized and in areas where the external callus is thin and translucent, pitting and erosion can be easily seen with a low magnification under the callus. This observation accords exactly with that of Bast, Sullivan and Geist.<sup>1</sup> Because of mobility, however, the fragment edges have rubbed together and small areas of polishing have resulted on the fragments. This is also noticeable in the tibia, No. 388 previously described, but it does not occur there in significant extent. It is more obvious in the human specimens about to be described. Polishing or eburnation develops with remarkable speed, thirteen days being quite enough to permit the production of a distinct result.

Figure 13 shows the right fifth rib from No. 1007, male, white, sixty years of age. There is but little erosion and vascularity of fragments, no erosion of fractured edges and but slight reaction in the form of external callus slightly greater in amount on the deep aspect. One would expect an exhibition of weak repair in a patient of sixty years. The bareness of the fractured edges and immediately adjacent bone is due to reduction in vitality induced by the rubbing together of the fragments which polished each other in the process.



## EARLY STAGES OF BONE REPAIR

Figure 14 shows the right eighth rib from No. 1173, a male, white, of forty years. Here are almost the same features as shown in the previous figure, but there is much more vigorous effort at repair since this patient was twenty years younger than the last. Nevertheless the bare areas of bone of low vitality are equally evident, thrown into stronger contrast by the more active repair process. Polishing or eburnation of the edges presents itself like the conchoidal chipped surfaces on a hand-flaked flint. Bast, Sullivan and Geist show very clearly that such bare areas of diminished vitality have had their periosteum stripped from them.

Recent fractures of ribs present features identical with those of fractured long bones, but owing to the greater liability to raising of the periosteum

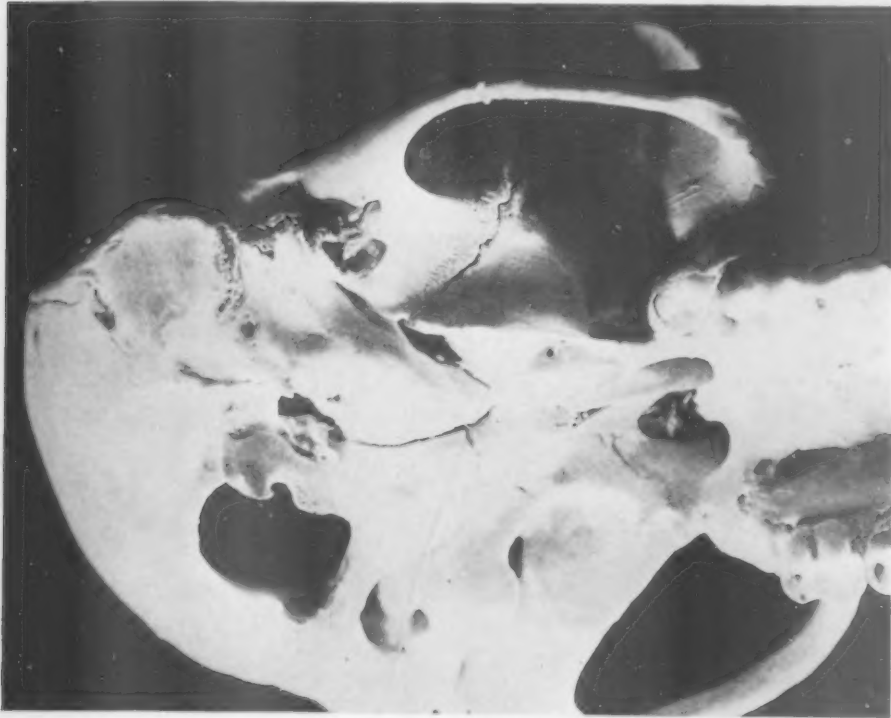


FIG. 18.—Base of same skull. Note vascularity indicating repair along the right inferior sphenotemporal suture.

and its more frequent occurrence over a relatively greater area, the bare areas of low vitality are more obtrusive. Again polished or eburnated edges are more widely spread owing to the utter impossibility of keeping the fragments from rubbing on each other.

*Repair in Vertebrae.*—Fractured vertebrae are by no means rare. Crushing fractures of the body are more frequent than fractures of the various muscular or articular processes. Where the cause of fractured body is direct violence the patient almost inevitably dies at once, but when the violence is applied indirectly good healing usually takes place. We have found no evidence of the laying bare of cortical areas of bone; repair it is true, is unequal but there are no isolated fragments such as are found in comminuted fractures of long bones. It is quite unnecessary to present any, even of our

recent fractures, but it can be stated upon the evidence presented by our dog, B835, that thirteen days are a long enough period for solid repair of a crushing fracture of the vertebral body.

*Repair in the Skull.*—Recent fractures of the skull are extremely rare. If the individual does not die immediately he lives long enough to lose all trace of the recent phenomena. We do have one Cercopithecus monkey, B1042, which suffered an atrocious comminuted fracture of the vault and lingered



FIG. 19.—Right parieto-occipital area of skull No. 1212, White, male, age forty-five years. Note vascularity and erosion indicating commencing healing in fracture which runs through or close to site of united right lambdoid suture.

for some days, perhaps as much as three weeks. But there is no history and we do not even know whether the fracture is simple or compound.

The recent healing fracture involves the entire right parietal bone, forces open the entire coronal and the right temporo-sphenoidal sutures, and has also a fissure running through the left parietal just behind the coronal suture. Typical repair with erosion, vascularization and new bone is apparent throughout the right parietal and in the fissured fracture of the left parietal but nowhere is to be seen in the sprung coronal suture. Curiously enough the sprung temporo-sphenoidal suture, especially its lower part, does show the vascular erosions typical of repair. Why there should be this peculiarity in location of repair, the singling out of one suture and the rejection of the other, is too large a problem for this paper and of no clinical significance. We shall therefore content ourselves with pointing out the facts and leaving the evidence for later development. Even throughout the right parietal bone repair is weak and quite as unequal in activity in different areas as in the other bones of the body. There is a generalized

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subperiosteal deposit of bone and a similar but less pronounced deposit on the dural aspect. (Figs. 15, 16, 17 and 18.)

The only quite recent fracture in a human skull at our disposal is shown in Fig. 19. This is the right parieto-occipital area of No. 1212, male, white, forty-five years, a patient in the insane asylum who died a few days after fracturing his skull. We have not succeeded in getting any clinical history. The figure shows the right lambdoid suture closed so far as it ever would have closed in this individual: it is a condition of the lambdoid typical of the patient's age. Vascular erosion is well marked all along the fracture but there are only scattered vestiges of callus.

Sufficient evidence is here given to show that there is no essential difference in principle of bone repair in the skull vault from other parts of the skeleton. Such modifications as exist are called forth by local conditions.

### GENERAL SUMMARY

The principles of bone repair are few and simple; their application very varied. The fragments show erosion and vascularity. Part of the erosion is undoubtedly removal of bone devitalized in the actual process of fracture; part is the channelling of old bone adjacent to the fracture by the burrowing and multiplication of blood-vessels which are bringing the necessary pabulum for nourishment of the repair cells. On the eroded areas of fractured face and adjacent surfaces, subperiosteal and endosteal or cancellous, there appears a callus of varying texture, finely granular in immobilized fragments, lava-like in those which are movable. Through successive stages this callus is transformed into a cancellous mass and later into tissue with Haversian systems. Ensheathing and endosteal callus become reduced or eliminated and the former so modified that a cortical waxy surface is developed. Definitive callus of course remains and goes through the corticization process also.

There is no difference in actual speed of development of these stages in different areas or fractures, but it is natural that a complete fracture cannot be solidly bridged so quickly as an incomplete one. Hence although the same features are to be observed in a complete as in a merely fissured fracture, and although they are to be found at the same date, the fissured or "green-stick" fracture will be completely healed in some twenty days, whereas a complete long bone fracture may, after the elapse of that time, show large masses of heaped-up lava-like callus with an as yet unbridged gap. An impacted fracture, say of a vertebral body, may be healed in thirteen days.

Inequality of vigor in repair is characteristic of the several parts of any fracture. In certain specimens this can be directly referred to bone damage by stress or strain at the actual instant of fracture, but in others the probable cause is more obscure.

Where periosteum is elevated from the bone adjacent to a fracture the bone oftentimes is diminished in vitality, shows no erosion and takes no active part in repair, although it is not dead and becomes ultimately passively incorporated in the new structural bone. It must not be inferred that the raised periosteum develops new bone. As a rule the cambium layer is destroyed and no new bone is formed at or over the stripped surface. Such instances are


found more frequently in rib fractures than in long bones and they never occur in vertebrae so far as the Reserve collection shows.

Free movement of fragments does not inhibit the normal repair process, but if fractured ends of low vitality rub against each other, and bone fragments cannot rub against each other without becoming reduced in vitality, friction facets speedily develop similar to the occlusal and interproximate facets on the teeth. Such facets develop within two weeks after fracture and are usually described as polished or eburnated areas. These are found most often in rib fractures but may appear in long bones. We have never seen them in fractured vertebrae.

The thin cortex of ribs and vertebrae results in entire absence of a type of comminuted fragment common in long bone fractures, namely the fragment of dense compact bone. Such fragments or parts of them may be reduced in vitality owing to the raising of the periosteum yet not killed. They show no activity in repair, but become passively a part of the new structural bone. Round these fragments, or areas if they be not separated from the main fragments, a fenestration usually develops in the external or ensheathing callus at the bottom of which the bone of diminished vitality can be seen.

Endosteum or cancellous tissue is of great importance in bone repair. Compact tissue takes but little part compared with endosteum and cambium layer in the formation of new bone; it acts as the scaffolding upon which the new bone is laid down. Where cancellous tissue is relatively most abundant and mobility feeble or absent, repair is quickest, namely in vertebrae, fissured and "greenstick" fractures.

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## THE JOINT COMPLICATIONS OF ACUTE OSTEOMYELITIS OR ACUTE EPIPHYSITIS

AND THE PRINCIPLES UNDERLYING THEIR TREATMENT

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IN instances of acute osteomyelitis, I have observed the focus of infection spreading into a joint. The mechanism of this secondary involvement is a manifold one.

1. In many of the cases the infection travels into the joint through the lymphatic channels. Under such conditions an effusion of serous fluid occurs in the joint, which at first is free from organisms but in which organisms can presently be demonstrated. Actual suppuration follows unless because of efficient treatment or other apparent or obscure cause the original focus begins to retrogress, becomes localized and goes on to healing. Sometimes the joint effusion stops just short of the bacteria-carrying stage and after remaining so for a variable time it eventually disappears spontaneously. Small "sympathetic" effusions of this kind quite commonly accompany foci of osteomyelitis which are close to a joint.

2. When the fixation point for the thrombus-embolus formation occurs in the bony structures entering into the architecture of a joint, any joint infection which follows is secondary to the focus in the bone by direct extension of the infection. The anatomical groundwork and the pathological changes which enter into the mechanism of these forms of infection have been previously described and will not be repeated here. Only those parts are summarized which have important bearings on the treatment of joint infection complicating osteomyelitis or epiphysitis.

In children (and young adults) the fixation point is commonly in the neighborhood of an epiphyseal line. Anatomically a number of possibilities are present depending upon the relationship of the local focus of infection in the bone to the joint capsule and the reflection of the synovial membrane. In some of the cases the local focus in the bone lies altogether outside of the joint interior; in others it lies outside of the joint interior only partially; in still others it lies altogether within the joint. This relationship is especially important in cases of epiphysitis and the observable clinical possibilities are as follows:

A. An epiphysitis develops with or without abscess formation, and during the entire course of the infection there is no demonstrable evidence pointing to involvement of the joint. The physical basis for this naturally lies in the location of the fixation point in that part of an epiphysis which is entirely outside the joint capsule.

B. An epiphysitis develops with or without abscess formation and the clinical signs of joint involvement come only later. If this should appear



before any operative incision, it indicates that the fixation point was originally situated in a part of an epiphysis which was outside the joint and that joint involvement took place because of the spread of the infection into that portion of the epiphysis which lay within the joint or because secondary sequestration opened a path into the joint. If the signs of joint involvement came after incision, the possibility is always present that the latter was due to the operative intervention, either accidentally or, perhaps, purposefully.

C. An acute joint infection develops and at operation it is possible to demonstrate a focus of infection in that part of the epiphysis which lies within the interior of the joint. It is immaterial whether the given epiphysis lies wholly or partially within the joint; the focus of infection is in that part of it which lies within the joint.

3. In a focus of infection in a bone and near one of its articular extremities it can happen that the gradual extension of the infection in the cancellous and cortical tissue results in more and more destruction of bone until a tract forms leading into the interior of the joint. I have been able to demonstrate this lesion several times during the course of an operation. The clinical course suggests that in some of the cases the bone lesion is a relatively minor one and had, perhaps, preëxisted for some time, and that an acute rupture takes place into the joint with the sudden development of high fever, with or without chills, and other signs of an acute infection of severe grade. Positive blood cultures are not common under such conditions. Commonly the bone lesion is not recognizable in the clinical picture; the joint infection is dominant. In other cases the development of the bone fistula into the joint is a gradual one and is not accompanied by signs of any acute new lesion, or of the exacerbation of a previously existing one; frequently, indeed, the arthritis is seen to develop slowly during the course of the post-operative dressings on an osteomyelitis wound nearby. In some of these cases it is possible to demonstrate at operation that the bone tissue intervening between the joint surface and the bone focus is carious, by the ease with which an ordinary probe can pass through it and by the macroscopic and microscopic appearances of the tissue.

4. During the course of an operation I have, on several occasions, been able to pass a probe from an extra-articular abscess directly into a joint. As will be pointed out later, perforation of a suppurating joint frequently occurs and the end-result would be indistinguishable from a lesion resulting from the perforation of an external abscess into the joint. However, in my experience, several of these were distinctly subperiosteal types of abscesses situated at the extremity of a bone and close to the joint and for that reason I am of the opinion that the direction of the perforating process was inward into the joint.

5. It is possible for both bone and joint to be simultaneously involved because of the formation of more than one fixation point. I am convinced that this is a common occurrence.

## THE JOINT COMPLICATIONS OF ACUTE OSTEOMYELITIS

In actual practice it is found that the relation of the local joint lesion to any general infection (bacteriæmia) can be of three clinical varieties:

a. In the first variety a focus is present in one of the joints with well-marked local signs and symptoms but without any clinical signs of a general blood infection. A bacteriæmia is not present. The physical basis for this variety lies (a) in a primary and temporary bacteriæmia; (b) in the development of a fixation point in a joint, and (c) in the subsequent spontaneous disappearance of the bacteriæmia.

b. In the second variety, a well-marked focus is present in one of the joints with abundant local signs and symptoms and, in addition, there are clinical indications of a bacteriæmia as evidenced by the general signs and symptoms and by the demonstration of living bacteria in the blood stream. The physical basis for this variety is the presence of an infected thrombus-embolus formation which serves to keep up a demonstrable bacteriæmia by constantly feeding into the blood stream a comparatively small number of viable organisms. It must be remembered that any of these cases may at any time pass into the third group.

c. The clinical picture of the cases in this group is that of a profound general infection. A local joint focus is either not demonstrable at all because of the paucity of local signs and symptoms, or because the latter are hidden in the profound intoxication; or, if present, the local lesion is easily recognized as being of no consequence in the total clinical picture. The physical basis for the clinical picture lies in an extreme and severe general blood infection with highly virulent organisms, in which the bacteria are being fed into, and, in addition, are rapidly multiplying in the blood stream, because of which the subject is rapidly being overwhelmed by a tremendous intoxication. The presence of the infected thrombus-embolus formation (fixation point) forms a negligible factor and the few organisms that are derived from this source play only a primary and inciting part in the production of the bacteriæmia; the subsequent multiplication in the blood stream depends on other factors, the most important of which lie in the high virulence of the infecting organism and in the poor resistance of the subject. An endocarditis is usually found under these conditions. In this variety the local point of fixation plays a very minor rôle in the production of any part of the clinical picture. Usually the local pathologic-anatomic picture in the given joint is not in an advanced stage at the time the lesion is exposed, either on the operating table, or, as more commonly happens, in the autopsy room.

In actual disease it seems certain that the cases differentiated in these groups form progressive stages each from the next preceding group. A case in group a, may pass into group b; and, conversely, a case in group b having been appropriately treated, may retrogress into group a, as it proceeds to healing and recovery. These interchanges are constantly occurring in clinical surgery. A case in group b may pass into group c, as previously noted;

usually under such conditions there is a continued progression until the eventual fatality. In actual practice cases in group c must necessarily first pass through the stages indicated by groups a and b; the time interval may be so short, however, owing to the virulence of the infecting organism, or the relative non-resistance of the subject, as to make these stages unrecognizable. One can explain the cases that apparently begin with the characteristics of the cases in group 3 in this way. In many cases characteristics can be distinguished which belong to both group b and group c, and so far as any case partakes of characteristics not belonging to its group, it differs in its clinical manifestations. I have never seen a case in group 3 retrogress spontaneously into group b; it seems almost impossible to believe that such retrogression can ever occur.

It is a matter of great difficulty to integrate properly the bacteriemia or general infection between (a) any demonstrable primary lesion (such, for instance, as a thrombosis of the lateral sinus, or a furuncle of the skin, etc.); (b) the secondary bone lesion (for instance, an acute epiphysitis in one of the extremities of a long bone, or an osteomyelitis of one of the small bones of the wrist or foot, etc.); and (c) the complicating joint infection. The following general rules can be used as clinical guides:

a. In many cases the primary lesion (furuncle of the skin, etc.) has entirely healed and is removed from consideration as a factor. The cases subsidiary to a thrombosis of the lateral sinus are difficult to interpret properly. As a general rule if the sinus operation has been properly done and the jugular vein has been efficiently tied, any subsequent bacteriemia should be referred elsewhere than to the ear condition. This rule will be found to be generally true. The only exceptions include those comparatively rare cases in which the thrombus formation in the lateral sinus spreads along the petrosal branches.

b. In any case the bone lesion plays a most important part in the maintenance of the bacteriemia. In actual practice the proof of this relationship is in the last analysis, based upon the therapeutic test (eradication of the bone focus) according to rules summarized on a previous occasion (*ANNALS OF SURGERY*, 1927, March, 428). This practical test is important especially in post-operative cases and when the primary lesion is obscure. When the primary lesion is demonstrable, the interpretation becomes a matter of exclusion.

When the bacteriological agent of the existing infection belongs in the staphylococcus group a bone lesion is always to be assumed.

c. Cases of joint infection produced by organisms of the pneumococcus or streptococcus groups are as a rule unassociated with bone lesions and in some of these positive blood cultures are obtained. In these instances the bacteriemia should be used as an indication that the primary lesion (such, for instance, as a streptococcus tonsillitis, or a pneumococcus pneumonia, etc.) to which the joint lesion is secondary still exists in a more or less active state.

## THE JOINT COMPLICATIONS OF ACUTE OSTEOMYELITIS

As a matter of fact, under such conditions the positive cultures are usually obtained in a comparatively early state of development of the primary and secondary lesions and disappear very shortly.

Joint infections occur as subsidiary lesions during severe bacteriæmias and general infections in which a bacterial endocarditis forms and becomes the main focus of distribution. Under such conditions bone lesions do not occur as intervening lesions between the bacteriæmia and the joint infection. These are usually the severest forms of general infection and the prognoses are extremely bad.

*The Treatment of the Local Joint Lesion.*—The treatment of the local lesion should be based (1) upon a consideration of the mechanism by which such foci are produced; (2) upon the character and complexity of the lesion which is produced, as determined by the available knowledge and röntgenographic evidence, especially as regards the associated osteomyelitis or epiphysitis; and (3) in accordance with the magnitude of the infection\* in association with the absence or presence of a bacteriæmia. Multiple joint foci should be treated individually along similar lines and in accordance with the viewpoints expressed.

A. Other things being equal, the absence of a demonstrable bacteriæmia or general blood infection indicates that a conservative attitude can be assumed in deciding the correct method of surgical treatment of the local lesion. The immediate importance of this conservative attitude comprises: (1) The avoidance of any operative intervention in many cases. Our best examples have been in the hips. Quite commonly these cases complicate the sinus thrombosis which follows an acute mastoiditis; and quite frequently the joint infection is secondary to a lesion in one or more of the epiphyses of the upper end of the femur. The clinical manifestations are largely due to the joint involvement. Even in the presence of high fever—frequently protracted for considerable periods of time—and of other signs of toxæmia, conservative forms of treatment are always indicated. The indications can be adequately met by traction and immobilization and the subsequent results have demonstrated that the natural antibacterial and healing forces of the body have been ample to control the general infection and the local focus and to bring about an efficient healing. The late results as regards function have been very good; curtailment of the normal ranges of motion have been inconsequential and of minor degrees or have been reduced to a minimum.

(2) A much less severe—frequently, indeed, a minor primary operation in the cases in which the operation should prove necessary.

(3) The much less chance of the spreading of the thrombo-phlebitic or thrombo-arteritic lesion with all the consequences hereinbefore outlined. This advantage, valuable beyond anything else, is guarded by the avoidance

\* The discussion of this aspect of the subject will not be repeated here. Cf. ANNALS OF SURGERY, March, 1927.

of any operative intervention and is least disturbed by the method of operative intervention indicated—the introduction of simple drainage.

(4) The conservation of important bone tissue. This is of maximum importance in any component which enters into the structure of a joint.

In the conservative treatment of joint infection complicating acute osteomyelitis, reliance should be placed upon traction and immobilization in association with general supportive measures, good food and efficient nursing. Later when the acuteness of the joint lesion has subsided gentle massage and extremely gentle passive and active motion should be instituted. In lower extremity lesions weight-bearing should not be allowed until every sign of activity in the joint lesion has been eliminated and all symptoms have disappeared. An efficient brace should be made and should be worn by the patient for from six months to one year. Under this régime I have seen repeatedly a gradual amelioration of the general and local symptoms and signs and a final healing of the lesion in the joint.

The only operative indication to meet under this plan of treatment is the introduction of adequate drainage when the local conditions call for it. Under the circumstances the necessity for operation arises only because of an excessive accumulation of purulent matter and the latter collects (a) within the interior of the neighboring joint, (b) exterior to it under the periosteum, or in the fascial planes of the limb, or (c) in more than one of these locations either simultaneously or as developments the one from the other. When the purulent collection is restricted to the interior of the joint and the joint capsule remains intact, operation is not usually or necessarily indicated. Collections of pus exterior to the joint, whether produced by perforation of the joint capsule or as a subperiosteal abscess, etc., must usually be incised and properly drained. In many cases this is all that is needed.

Perforation of the joint capsule is a fairly common complication. Extra-articular abscesses then form which usually follow certain definite courses in their development depending on the individual joint and its anatomical relations. It is well to know these. It happens not so very rarely that patients are admitted to the hospital with larger or smaller abscesses between the fascial planes in the depths of the extremities which do not heal in the usually expected way after they have been properly incised and drained. The persistence of an abundant purulent discharge from the wounds make it apparent finally that the discharge is being fed from some primary focus which proves almost always to be a suppurative arthritis in the neighboring joint with or without an associated osteomyelitis. It is a curious clinical fact that in some of the cases the subjective symptoms have either not been referred to the given joint, or that the objective relationship is not recognized. Healing occurs finally only when the primary foci—joint, or bone, or both of these—have been properly attended to.

The more characteristic of these lesions follow:

1. Suppuration within the knee-joint perforates through the posterior



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surface of the capsule and spreads out in the popliteal space; further extension occurs downward between both heads of the gastrocnemius muscle and then between the belly of the latter and the underlying soleus muscle. A large abscess then forms in the calf of the leg. In addition to incising the abscess in the calf, the knee-joint itself should be properly drained on both its lateral aspects anteriorly.

2. Suppuration within the hip-joint follows one of three paths in perforating through its capsule. The perforation never occurs through the substance of the ileo-femoral (Y) ligament but on either side of it.

a. When perforation occurs at the inner aspect of the Y ligamentum pus collects between the adductor muscles and the abscess points in the fold of the groin over the pubic ramus. Drainage should be established at this point in addition to the classical method of draining the hip-joint proper.

b. When the perforation occurs on the outer aspect of the Y ligamentum pus collects exterior to the joint on its outer side and between the rectus, the sartorius and the tensor fascia femoris muscles. In the interval between the latter two muscles the pus perforates the deep fascia of the thigh and a large subcutaneous abscess forms lying on the outer side of the thigh and extending around to its anterior and posterior surfaces. Incision of the abscess should be carried high enough so that drainage can be established into the hip-joint in the usual way.

c. Perforation through the posterior part of the capsule occurs in the neighborhood of the cotyloid notch. An abscess forms exterior to the joint in and between the glutei muscles. It is difficult to drain the hip-joint through its posterior aspect and it is better to open the hip-joint in the classical way on its outer and anterior aspects in addition to draining the external abscess in the buttock.

Suppuration within the hip-joint perforates not so rarely through the centre of the acetabulum. A subperiosteal abscess then forms on the pelvic side of the innominate bone opposite the acetabulum which is easily palpated by rectum. Extension occurs under the pelvic fascia and a pelvic abscess results; or extension occurs in an upward direction toward the iliac fossa where the abscess points extraperitoneally above Poupart's ligamentum.

3. The point of election for perforation of the shoulder-joint is on its anterior aspect. The perforation occurs internal to the lesser tuberosity and the abscess spreads out beneath the tendon of the subscapularis muscle. The tumefaction is best felt in the axilla. Or it comes forward between the deltoid and pectoralis major muscles and points in the general neighborhood between the latter two muscles. A large subcutaneous abscess sometimes forms which covers the outer aspect of the shoulder.

4. In the small joints of the hand and foot, perforation usually occurs on the anterior or flexor surface of the joints.

In a general way the actual methods of introducing drainage follow approved surgical principles and comprise (a) the simple opening of abscesses in the soft parts; (b) the opening and drainage of subperiosteal abscesses;

and (c) the various forms of arthrotomy and drainage for the individual joints. In given cases and under proper circumstances the use of Dakin's solution forms an important part of the after treatment of the operative wounds. The Willems method of treatment does not find a place in the treatment of the forms of suppurative arthritis which complicate acute osteomyelitis or acute epiphysitis. Theoretically, this method might be of value in those comparatively few cases in which the joint exudation approaches the type referred to as "sympathetic effusion," in which the latter is bacteriologically sterile, and in which diseased bone does not reach into the interior of the joint, in such cases we have come to believe that operation upon the joint is not indicated. Similar efforts and care should, however, be exercised in the after care of the operated cases as was described in the non-operative treatment, comprising traction and immobilization, general care and nursing, subsequent massage and gradual assumption of motion, the elimination of weight-bearing and the prolonged use of a brace.

The treatment of the associated acute osteomyelitis or acute epiphysitis follows the general rules and indications summarized in a previous communication (*ANNALS OF SURGERY*, March, 1927). No discrepancies of any kind will be found between the general rules by which the bone lesions and the joint complications are to be treated; as a general rule the indications and methods are so closely interrelated that the adequate treatment of the one will include the efficient treatment of the other.

The indications and opportunities for secondary operations upon these cases are relatively few because of a number of reasons: (1) These cases are most commonly found in young children in whom the capabilities for natural spontaneous regression and healing are at their maximum. (2) Most of these joint infections complicate lesions in the epiphyses. Owing to the structure of the latter the bone foci are necessarily limited in size; the resulting sequestra are small; and within the confines of a joint absorption of the latter is a phenomenon of extraordinary rapidity. (3) Many times there is no indication for operation because the sequestra which do form are relatively small and are easily discharged from the wounds made originally for drainage. Thereafter the wounds close spontaneously.

In the exceptional case the persistence of necrotic bone tissue makes it necessary to perform secondary sequestrotomy. Only as much healthy bone or involucrum should be removed as to enable one adequately to remove the sequestrum. The main care is not to cause undue mutilation and to prevent the spread of the thrombo-phlebitis inasmuch as this is the chief cause for the subsequent exacerbations or recrudescences in the same focus or in the production of other foci. The resulting wounds should not be sutured and should be allowed to heal from the bottom, either with or without the aid of sterilization by the Carrel-Dakin method.

The results of this conservative plan of treatment for cases of joint infection complicating acute osteomyelitis (including epiphysitis) have been

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very good in our experience when this plan can be consistently followed. There has been a greater usefulness because of a greater conservation of important bone structures, because of less profound changes in the interior of the joints and in the soft parts surrounding them and because of milder disturbances in the range of joint motion.

B. Other things being equal, the presence of a demonstrable bacteraemia or general blood infection indicates a dangerous and possibly progressive lesion and bespeaks an urgency of effort which seeks to remove the guilty local focus as early and as completely as possible before irreparable damage is done by the spreading of the infection to the endocardium or other important organ or locality. All of the information classified in the previous part of this and in other papers as regards the clinical and the therapeutic significance of a bacteraemia or general blood infection from the surgical standpoint, especially as it accompanies an acute osteomyelitis or epiphysitis, come into play at this time and judgments should be based and indications met accordingly. These statements and those hereinafter made hold true except in the very mildest cases of bacteraemia; in these a conservative attitude along the lines hereinbefore indicated is permissible as it is found clinically that these cases behave practically in much the same way as the cases with sterile blood cultures. A policy of extreme watchfulness is, however, highly important until the bacteraemia disappears. The subsequent discussion should be understood in the light of this reservation.

The important indication is to remove the local focus of osteomyelitis or epiphysitis to which the joint infection is secondary as completely as possible. Conservatism should be replaced by the radical removal of bone tissue frequently into healthy areas. It is found clinically, however, that this indication cannot always be adequately met and there are times and localities in which the radical removal of the thrombo-phlebitic foci of osteomyelitis (or epiphysitis) is not technically feasible. This is so because of a number of factors:

1. The impossibility of determining clinically, or of demarcating accurately even upon operative exposure, the exact extent of disease in any given bone is an important characteristic of the early stages of the development of a focus or infection in osseous tissue and prevents one from eradicating the latter adequately. The physical basis for this exists in the manner and extent of intraosseous vascular clotting, of the consequent disturbance of intraosseous circulation and of the capabilities for collateral blood supply. Owing to the physical structure of the bone, changes are not visible to the unaided eye or on an X-ray photograph at these comparatively early stages of the development of the focus, *i.e.*, at the time these cases are usually operated upon. Röntgenological evidence of all these structural changes only become recognizable (a) after the bone cells have died and after the bone matrix has begun to sequester, in which case the discriminating shadows forming lines of demarcation and areas of absorption, rarefaction find their physical basis in the disappearance of lime salts; and (2) after

new bone—involucrum—has been deposited around the sequestered portions, in which case the discriminatory shadows are due to the deposition of new lime-bearing tissue; both of these physical conditions are the products of long-continued activity of processes of disease and of processes of healing and only become recognizable at a late stage. Röntgenological evidences of the "first appearances and of the subsequent development" of a focus of osteomyelitis in an epiphysis, are very liable to mislead one unless they are properly interpreted.

2. Epiphyses are commonly important component parts of joint structures. Under the circumstances the times and localities in which radical removal of the thrombo-phlebitic focus in the epiphysis is not technically possible are frequent. In addition the immediate proximity to important conjugal cartilages, and the wish to conserve as much as possible of the skeletal structure in order to preserve as much as possible of the normal growth and functions, makes undesirable any radical removal of the focus of infection in an epiphysis.

In actual practice these two criteria frequently disturb and prevent ideal methods of treatment of the local epiphyseal lesion in the presence of a bacteraemia. As much as possible should, however, be done in the way of removing the entire focus; ample drainage should be secured in addition as the next best thing; and a good deal must be entrusted to nature's efforts in spontaneously dissipating the bacteraemia. In actual practice this incomplete method of treatment works out fairly well in the milder and moderately severe type of bacteraemia; spontaneous regression and disappearance of the general infection frequently takes place and the disease continues as if no bacteraemia had existed. In the severe type of general blood infection, one is frequently compelled to disregard anatomical structure and subsequent disturbance of function and to proceed ruthlessly to remove the entire focus of infection; the question of amputation frequently comes up; success does not always follow. In the most severe type of infection—as indicated in a previous part of this discussion—it should be recognized that operation is futile.

The experiences upon which the discussion in this communication is based is derived from clinical observations upon patients admitted to the service of Dr. A. V. Moschowitz at Mount Sinai Hospital and upon patients in my own private practice. I am indebted to Doctor Moschowitz for permission to carry on some of these observations upon the patients admitted to his service.

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## THE SIMULATION OF GALL-BLADDER DISEASE BY INTERCOSTAL NEURALGIA OF THE ABDOMINAL WALL\*

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WHEN the pain and tenderness of intercostal neuralgia involve the upper right abdomen they may closely simulate, and may be easily mistaken for the pain and tenderness of gall-bladder disease.

In an earlier paper I discussed "Intercostal Neuralgia as a Cause of Abdominal Pain and Tenderness"<sup>1</sup> and I described tests to differentiate parietal neuralgia from the intra-abdominal lesions which it simulates. Pending a suggestion by some one of a more suitable appellation, I employ the term "intercostal neuralgia" to include every condition that may give rise to pain and tenderness of the intercostal nerves. Clinicians seldom consider the possibility of abdominal pain and tenderness being located in the abdominal wall itself with the result that a very common parietal affection—intercostal neuralgia—is erroneously diagnosed as an intra-abdominal, pelvic, or genito-urinary lesion.

The entire nerve supply of the anterior abdominal wall comes from the sixth to the twelfth intercostal and first lumbar nerves. Neuralgia of the tenth, eleventh, or twelfth intercostal or first lumbar nerve on the right side is commonly mistaken for appendicitis, as I have endeavored to explain in two recent papers on "Chronic"<sup>2</sup> and "Acute"<sup>3</sup> "Pseudo-appendicitis." These three earlier papers discuss many points that are pertinent to the subject of gall-bladder disease, but time and space forbid their repetition here.

The sixth to the tenth right intercostal nerves supply the right upper quadrant of the anterior abdominal wall. Painful affections of these nerves—both acute and chronic—are incredibly common and cause pain and tenderness which are frequently mistaken for acute or chronic biliary lesions. Many writers state that the clinical diagnosis of gall-bladder disease is easily made on the history and physical examination; but my own observations indicate that—with the exception of indigestion, jaundice and palpable gall-bladder—the history, symptoms and bedside signs of gall-bladder disease and biliary colic can be simulated perfectly by painful affections of the intercostal nerves.

There are many diagnostic fallacies shared in common by the gall-bladder and the vermiform appendix. Chronic inflammation incident to advancing age occurs in both these organs with such frequency that it should be regarded as an almost universal finding beyond middle life. In a paper on "The Gall-bladder of 1926"<sup>4</sup> Charles H. Mayo states that there are few necropsies on persons aged forty or over in which the appendix is normal and that the

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same also holds true for the liver and gall-bladder. These facts are coming into general recognition in the case of the appendix, but are largely ignored in the case of the gall-bladder. Numerous writers assert that the real post-operative test as to the correctness of a pre-operative diagnosis of chronic appendicitis must not be based upon what the microscope shows in the way of chronic changes but should be determined by the clinical test of whether



FIG. 1.—Biliary and appendiceal triangles. The rectangle is the upper thigh area of hyperesthesia due to neuralgia of the right ilio-inguinal nerve. Single cross is point of election for testing for ilio-inguinal nerve tenderness in thigh. Circle is the anterior superior iliac spine. Row of crosses represent "tender points" along left rectus muscle.

or not the symptoms for which the patient sought relief are cured or greatly benefited by the appendectomy. I have not seen any analogous statement pertaining to the gall-bladder, although failure to relieve symptoms is a frequent sequence of cholecystectomy. In other words, the mere finding of a grossly or microscopically diseased appendix or gall-bladder at operation does not prove that the pre-operative symptoms in their vicinity were caused by these organs and will be relieved by their removal. In my experience the commonest cause of abdominal pain and tenderness which are not relieved by appendectomy or cholecystectomy is intercostal neuralgia. It is also my experience that in the majority of the patients who are referred to me with a diagnosis of gall-bladder disease, the pain and tenderness are parietal rather than intra-abdominal.

The right half of the abdomen may be arbitrarily divided into two triangles. (Fig. 1.) The lower or appendiceal triangle is bounded by lines extending between the umbilicus, the crest of the right ileum and the pubes; and the upper or biliary triangle by lines joining the umbilicus, the tip of the xyphoid and the right iliac crest. The parietal pain and tenderness of intercostal neuralgia are commonly mistaken for appendiceal symptoms when they occur in the lower triangle, and for biliary symptoms when they occur in the upper

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triangle. Many surgeons who have learned that appendectomy will not cure the chronic pain and tenderness of the appendiceal triangle have not yet learned that the same chronic pain and tenderness of the upper triangle are not cured by biliary operations.

The recognition of the presence of intercostal neuralgia in the biliary triangle is very important from several different angles. (1) Parietal neuralgia may be the only cause for the patient's symptoms and a biliary operation is therefore contra-indicated. (2) Parietal neuralgia may accompany and mask serious gall-bladder disease requiring the utmost diagnostic skill to detect the latter lesion. (3) Biliary operations as a rule do not cure parietal neuralgia, hence patients should be warned before operation that the neuralgia symptoms will persist and require special treatment, otherwise they and their physicians regard the late results as surgical failures. Theoretically, the removal of a toxic focus by cholecystectomy might be expected to cure parietal neuralgia, but unfortunately it commonly fails to do so. (4) An exacerbation in neuralgia symptoms may be anticipated during the first four or five days after a biliary operation possibly due to over-extension of the spine on the operating table. Recognition of excessive post-operative pain and tenderness being due to parietal neuralgia will save the surgeon from anxiety during the first day or two regarding a possible beginning diffuse peritonitis and on later days will save the patient from being regarded as a neurotic or malingerer.

The spontaneous parietal pain of intercostal neuralgia varies greatly in intensity in different patients and in the same patient at different times. Even when all the intercostal nerves of one or both sides are affected the patients seldom complain of spontaneous pain except over the soft anterior walls of the abdomen. Female patients, however, may complain of neuralgic pain in one or both breasts and patients of both sexes may complain of spontaneous pain at the angle of the right scapula quite similar to the referred pain of biliary colic.

The intercostal nerve irritation may be so slight that the patient may not have any spontaneous abdominal pain, even when the objective tests I shall describe are all positive. In exceptional instances the pain of neuralgia may be as intense as the most severe colic or strangulation. In between these extremes all grades of severity of spontaneous pain are encountered.

Spontaneous pain may be so constant as to be present every waking moment for weeks, months or years, or it may occur as intermittent attacks lasting hours or days with days or weeks of freedom quite similar to mild or severe attacks of biliary colic irrespective of whether the gall-bladder is present or has been excised. The acute attacks may be apparently causeless or may follow active exercise or a focal infection, especially of the upper respiratory tract. In the last event there is often associated a low grade of transient fever and leucocytosis, and if these occur in a patient whose neuralgic pain is manifested both in the biliary triangle and in the right subscapular region, the similarity to subacute cholecystitis is very striking.

In several recent papers emphasis has been placed on the biliary distress

commonly occurring for the first time during the puerperium. I have seen several cases of undoubted intercostal neuralgia in which the first symptoms arose during the puerperium. I believe neuralgia is most commonly due to various distortions of the spine resulting from many causes, including in a minor way pregnancy and labor.

Like biliary distress, the pain of intercostal neuralgia may come on during the sleeping hours and is then often due to a mattress or springs which cause harmful strain on the spine and is prevented by the patient changing to another bed.

Intercostal neuralgia may be encountered in visceroptotic individuals and some of the indigestion symptoms due to visceroptosis or intestinal stasis are quite similar to those of gall-bladder disease. Flatulence and belching are often caused by gall-bladder disease, but the frequent failure of cholecystectomy to abolish them indicates they are often due to other lesions. I concur in Judd's statement that "very few normal persons are entirely free from some of the symptoms of dyspepsia." Furthermore, I have gained the impression but am by no means positive, that upper abdominal distress following a full meal and relieved by vomiting may be due to parietal intercostal neuralgia. Patients with neuralgia are frequently encountered who cannot tolerate belts, corsets, or even snug-fitting clothing because of hypersensitiveness of the skin. A similar neuralgic hypersensitiveness of the epigastric anterior parietal peritoneum might render the pressure of a full stomach intolerable and relief would be obtained by vomiting.

An earlier jaundice may have been due to a catarrhal inflammation and therefore without significance in the diagnosis of the patient's present condition. Again many patients confuse jaundice with sallow complexion.

The points of similarity that have been cited are enough to indicate that history and subjective symptoms in the absence of jaundice or palpable gall-bladder are not very helpful in arriving at a correct differential diagnosis between biliary disease and parietal neuralgia. Furthermore these two affections cannot be differentiated by the customary methods of bedside physical examination.

The usual practice of conducting abdominal palpation only when the muscles are fully relaxed fails to indicate the superficial location of parietal tenderness in intercostal neuralgia and leads very commonly to the erroneous assumption that the tenderness is caused by a lesion in an underlying viscus. I have devised a simple bedside test to detect tenderness of the abdominal parieties. Every patient in whom abdominal tenderness is found should be subjected to this test. The patient is instructed to hold his abdominal muscles as tense as possible by contracting his diaphragm or by raising both heels from the bed with knees extended while the examiner makes firm abdominal palpation. Any tenderness thus elicited will be parietal in location. Tenderness elicited over relaxed abdominal muscles may be either parietal or intra-abdominal in location.

By far the most frequent cause of parietal tenderness is intercostal

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neuralgia. In my three earlier papers I detailed extensive tests to demonstrate the presence of intercostal neuralgia. Briefly they consist as a rule in finding: (1) Tenderness to palpation over voluntarily tensed muscles over more or less of—or even extending beyond—the biliary triangle; (2) tenderness over the same triangular area elicited by pinching a liberal fold of abdominal skin and fat between the thumb and two first fingers; and (3) tenderness along some or all the nerve trunks in the sixth to the tenth right intercostal spaces.

Neuralgia often is not limited to the sixth to tenth intercostal nerves on the right side and in that event there will be a corresponding increase beyond the biliary triangle over which tenderness can be elicited by each of the three above tests. All twelve intercostal and the first lumbar nerves or any lesser number of them may be involved either unilaterally or bilaterally. When either or both the twelfth intercostal and first lumbar nerves are involved there will be found a characteristic area of palpation tenderness over the buttock on the same side corresponding to the area of terminal distribution of the iliac branches of the twelfth intercostal, iliohypogastric and ilio-inguinal nerves. Neuralgia of the ilio-inguinal nerve produces tenderness in the upper thigh. (Fig. 1.) When the topmost intercostal nerves are affected pinch tenderness of skin and fat will be found in the arm near the posterior axillary fold in the area supplied by filaments of the second intercostal which are carried in the intercosto-humeral nerve.

In those cases of parietal neuralgia in which palpation tenderness is fairly evenly diffused over part or all of the biliary triangle, there will generally be found certain "tender points" (Fig. 1), exhibiting much more profound tenderness along the outer edge of the right rectus muscle. These "tender points" probably correspond to the points (Fig. 2) at which



FIG. 2.—Dissection to demonstrate branches of intercostal nerves where they enter the rectus abdominis muscle. (From Spalteholz.)

intercostal nerve branches perforate the transversalis fascia and aponeurosis to enter the rectus muscle. One of these "tender points" is commonly found at the tip of the ninth or tenth costal cartilage and by the usual method of palpation is very apt to be mistaken for the localized tenderness of a sensitive gall-bladder. A neuralgic "tender point" situated at or near the right costal arch will give a perfect and characteristically positive response to Murphy's gall-bladder tenderness test. This test consists of "hooking" the fingers under the costal arch while the patient attempts a deep inspiration. A sudden painful cessation of inspiration is supposed to indicate the presence of a tender gall-bladder which has been forced downward against the examiner's fingers. The sharply localized area of tenderness demonstrated by slight shifts of the position of the fingers in making this test has heretofore been regarded as confirmation of the tenderness being confined to the gall-bladder. A parietal "tender point" of intercostal neuralgia will give exactly the same response as a tender gall-bladder to the above tests. I have repeatedly demonstrated to students that the Murphy test will give a positive response at the left costal arch and at the right costal arch even after cholecystectomy when the middle finger of the palpating hand is placed exactly upon one of the "tender points" of intercostal neuralgia while the patient attempts deep inspiration. Although the examiner's fingers are held in a fixed position in making this test, yet more pressure is exerted upon the "tender point" because it is forced against the middle finger by the inspiratory effort. Every observant surgeon is aware that the position of the gall-bladder as revealed by operation very frequently is far removed from the site of pre-operative localized tenderness as determined by a positive Murphy test. In such instances the localized tenderness is due to a neuralgic "tender point" in the abdominal parietes.

That the localized tenderness of intercostal neuralgia is in and not beneath the parietes can be shown by the examiner keeping the end of his middle finger exactly but gently on the sensitive area disclosed by the Murphy test until the patient voluntarily makes and holds his abdominal muscles tense and then by reapplying finger pressure the tenderness demonstrated must be parietal because the tense abdominal muscles prevent the finger exerting pressure on the gall-bladder.

That the tenderness of the same "tender point" or of some other "tender point" further down alongside the right rectus (or if the neuralgia is bilateral alongside the left rectus) is parietal, can also be demonstrated by the examiner indenting the abdominal wall with the end of his middle finger to a depth just short of causing pain, and holding his finger rigidly at that depth while the patient endeavors to take a deep inspiration. The pain caused by forcing the "tender point" against the fixed finger will cause the same sudden suspension of inspiration as in the Murphy test. In some cases the diffuse tenderness is so marked that interruption of the inspiratory effort



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will occur at whatever point the Murphy test is applied along or near the costal arch without reference to the finger being placed on a "tender point". In those cases in which the neuralgic pain and tenderness are fully developed their parietal location can be readily determined by the various tests which have been described. At the time many patients first come under observation, however, the neuralgic pain and tenderness may be at a low ebb and the only evidence obtainable may consist of the "tender points" with or without a more diffuse area of lesser palpation tenderness within the biliary area. Under such circumstances spontaneous pain, pinch tenderness of skin and fat, and pressure tenderness of nerve trunks may be entirely absent. Palpation by finger end poking over the voluntarily tensed abdominal muscles reveals the parietal location of the tenderness even in these mild cases of neuralgia. Doubt as to the parietal location of the tenderness in any given case can be cleared up by "blocking" the affected intercostal nerve trunks with novocaine.

Failure to recognize the presence of intercostal neuralgia in the biliary region commonly leads to the error of ascribing the neuralgic pain and tenderness (1) to hysteria or other neurotic causes, or (2) to gall-bladder disease directly or, (3) to a viscero-parietal-sensory reflex from gall-bladder disease.

An erroneous pre-operative diagnosis of hysteria or semi-malingering is most frequent in the cases in which the neuralgic pain and tenderness are too widespread to be accounted for by any single visceral lesion either of the gall-bladder or any other organ. An erroneous post-operative diagnosis of hysteria usually results from persistence of the neuralgic pain and tenderness after cholecystectomy.

In an interesting paper on the high percentage of unsatisfactory end results of operations on stoneless gall-bladders, Stanton<sup>6</sup> states: "Three patients after operation were found to be suffering from hysteria and not gall-bladder disease. Until we develop some pathognomonic, hysteria-proof sign for gall-bladder disease, the abdominal surgeon will probably continue to be fooled now and then by patients suffering from hysteria. The woman with hysteria and a fair knowledge of the symptomatology of gall-bladder attacks is a dangerous diagnostic possibility."

And again Stanton states: "The next group, containing fifteen cases, is made up of five cholecystostomies and ten cholecystectomies, all reporting cured or satisfactorily improved at the time of the last end result note, but in none of these cases can I demonstrate a one to one cause and effect relationship between the operation and the final result. Either final recovery took place months or years after the operation, or there have been intervening recurrent attacks of symptoms indistinguishable from those for which the patient was operated on."

In another group Stanton found: "Ten patients, when last heard from, were still suffering from abdominal symptoms similar to those for which their operation was performed." The pathologic changes recorded in the latter two groups of twenty-five not benefited by operation were not very definite.

My experience with intercostal neuralgia indicates that it was the probable affection responsible for the great majority of Stanton's twenty-eight operative failures.

Deaver and Bortz<sup>8</sup> report that: "Highly neurotic persons will often exhibit a continuance of symptoms after removal of a definitely diseased gall-bladder with or

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without stones, and in this series many of the patients examined in the follow-up department, complaining of persistence of symptoms, were of this type."

Of 217 patients traced after operations for gall-stones Seulberger<sup>7</sup> found 173 free from symptoms and twenty required re-operation. He has found that the post-operative symptoms often ascribed to adhesions are frequently relieved by paravertebral injections of procain.

Of 120 patients who survived biliary operation, mainly cholecystectomies, Brentano<sup>8</sup> reports the end results as being complete cures in 71, improvement with persistence of a few painful crises in 23 and recurrence of pain in epigastrium and tenderness in gall-bladder region in 26.

Of 23 cholecystectomies for non-calculous cholecystitis Steden<sup>9</sup> reports the pains persisted in half of them and in one was so severe that a second operation was done for suspected duodenal ulcer but nothing was found. Of 164 cholecystectomies for gall-stones 56 have remained free from pain and in 24 the post-operative painful manifestations have been severe.

Judd<sup>10</sup> states that gall-bladder operations based on clinical symptoms alone are likely to fail. He has found that repeated colicky pains is a fairly common complaint among the groups of patients who were not entirely cured at the end of a five-year period following gall-bladder operations.

None of the preceding writers attempted to differentiate parietal pain from intra-abdominal pain in their cases of biliary affections.

The writers who are aware of the parietal location of tenderness in suspected gall-bladder disease are confined almost entirely to the small percentage of clinicians who believe in the viscero-parietal-sensory reflex as described by McKenzie, Head and others. The various views relative to this reflex are summarized by Akana, Greeley and Farr<sup>11</sup> in their paper on referred pain in 424 consecutive cases of gall-bladder disease confirmed by operation in all but five which were not operated upon. These three co-authors apparently did not test for superficial hyperæsthesia but based their paper on patients' statements as to the pain radiations. The pre-operative diagnosis proved erroneous in about 13 per cent. of their cases. In ten of their patients there was no pain.

In addition to pains in the epigastrium, right hypochondrium, and right back they describe pains as being referred to right testicle, to both shoulders, to the lumbar region, to the chest, across the abdomen, to right lower quadrant, to left lower quadrant, to left shoulder, to both shoulders and left arm, to the heart, to the "sides", to left hypochondrium, to the lower abdomen, and to the left lower quadrant. I do not believe that gall-bladder disease gives rise to such widespread pain in the absence of complicating peritonitis. The finding of gall-stones and suppurative or gangrenous cholecystitis at operation does not prove that distant pains are due to the biliary lesions. Unfortunately these authors do not give end results, otherwise I suspect they would find that these distant—and even many of the local—pains have persisted since operation and are due to intercostal neuralgia.

Livingston<sup>12</sup> is a staunch supporter of the viscero-parietal-sensory reflex in diseases of the appendix, gall-bladder and kidney. By "positive skin signs for gall-bladder

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disease" he means "cutaneous hyperæsthesia that is present on the anterior abdominal wall, localized approximately within a two-inch radius from the tip of the ninth costal cartilage and maximal at that point. The lower limit of the hyperæsthesia does not reach to the level of the umbilicus nor does the upper limit extend upward as far as the breast, nor does it extend to the left of the midline. The method of testing consists of "a vigorous twisting pinch." Of 22 cases operated upon for "acute cholelithiasis or acute cholecystitis" "positive skin signs" were present in 20 and absent in 2. One of the negative cases had both gall-stones and kidney stones, the skin signs being negative for cholelithiasis and positive for nephrolithiasis. The second negative case was a common duct obstruction by stone with jaundice and without colic. Unfortunately Livingston does not give any details as to the pathological condition of the gall-bladders nor does he make any statements relative to the disappearance of the pains after operation.

Cope,<sup>12</sup> who believes in the viscerosensory reflex investigated cutaneous hyperæsthesia by pin-stroking and gentle pinching of the skin in 16 cases of acute disease of the biliary tract and found the skin signs positive in only six. The hypersensitive areas were not the same in any two cases and none of them corresponded to the area described by Livingston. In one of Cope's cases that gave skin signs similar to one of the six positive cases, exploratory laparotomy failed to reveal any lesion and a diagnosis of diaphragmatic pleurisy was then made although friction rubs were never heard.

I am whole-heartedly antagonistic to the theory of a diseased gall-bladder or any other abdominal viscus giving rise to a viscerosensory reflex as manifested by cutaneous hyperæsthesia of the abdominal wall. The majority of intra-abdominal lesions do not exhibit skin tenderness. The great majority of patients who have skin tenderness do not have intra-abdominal lesions of any consequence. Operations for either insignificant or gross visceral disease as a rule are not followed by permanent loss of chronic cutaneous hyperæsthesia. Transient loss or abatement of the hyperæsthesia may occur as the result of incidental rest in bed, but a follow-up for a year or more commonly demonstrates recurrence of the skin tenderness. In my opinion the occasional permanent loss of parietal tenderness after operation may rarely be due to removal of a toxic focus but much more frequently is due to factors other than the operation itself.

In every case suspected of having any intra-abdominal lesion it is important to examine the parietes by palpation over tense muscles for the signs of intercostal neuralgia. The absence of parietal tenderness in any patient complaining of abdominal pain and tenderness strongly substantiates the diagnosis of a visceral lesion. A positive Murphy test in the absence of parietal tenderness points definitely to a diseased gall-bladder, but true sub-parietal tenderness is relatively rare, even in the presence of marked disease confined to the gall-bladder. Sub-parietal tenderness is encountered more frequently in complicating peritonitis. The presence of parietal tenderness does not exclude a co-existent visceral lesion, but in arriving at the latter diagnosis the clinician should carefully consider the possibility of all the pain and tenderness being due to parietal neuralgia.

The history and bedside examination are often insufficient to establish the presence or absence of a visceral lesion, especially gall-bladder disease, when the picture is obscured by parietal neuralgia and resort must then be made

to all other available diagnostic methods. The presence of overlying parietal neuralgia very commonly prevents bedside determination of the presence or absence of gall-stones or biliary disease unless an enlarged gall-bladder can be definitely demonstrated. Under these circumstances the bedside examination needs to be supplemented by the Graham cholecystographic test, by gastro-intestinal X-ray examinations and by diagnostic bile drainage, before arriving at a final decision. Any one of these three supplementary examinations may demonstrate the presence of gall-stones or biliary disease but none of them is infallible, especially in a negative way, in all cases.

The Graham dye test may occasionally aid in visualizing gall-stones or more commonly may indicate functional disturbance either by an absent or faint shadow of the gall-bladder or by delayed disappearance of the gall-bladder shadow after the fat meal.

Röntgenological examinations may rarely demonstrate gall-stones but more commonly they disclose evidence of biliary disease indirectly by absence of lesions within the stomach and duodenum and by the presence of adhesions which distort the latter two viscera and displace them to the right.

By diagnostic bile drainage the finding of cholesterol crystals and bilirubin calcium pigment in the "B" fraction of bile fairly consistently indicates the presence of gall-stones. Failure to obtain "B" bile suggests a gall-bladder with rigid walls or full of stones or an obstruction of the cystic duct usually by stone but needs to be checked by a Graham test. The findings suggestive of non-calculous cholecystitis may consist of absence of "B" bile; or of excessive concentration of "B" bile due to abnormal stasis; or, of columnar epithelial cells, bacteria and mucus all of which are bile stained.

Unless some one of these three supplementary examinations gives very positive evidence of gall-stones or cholecystitis; or unless there is a reliable history or actual presence of jaundice; or unless an enlarged gall-bladder is demonstrable or unless constitutional and local symptoms, especially rigidity, indicate acute cholecystitis, I refrain from operation whenever I detect the presence of intercostal neuralgia in the biliary triangle regardless of the presence of what have heretofore been considered characteristic history and bedside findings of chronic or recurrent gall-bladder disease. I prefer to study those patients during an acute attack when I often find that their symptoms disappear by anæsthetization of the intercostal nerve trunks with novocaine.

Charles H. Mayo<sup>14</sup> very correctly states: "Years ago when diagnosis was less accurate the term 'neuralgia of the stomach' other than syphilitic obscured many a gall-bladder colic." The diagnostic pendulum has swung so far in the opposite direction that very few clinicians now consider the possibility of "neuralgia other than syphilitic" being the cause of symptoms in suspected gall-bladder cases. Routine pre-operative search for the signs of intercostal neuralgia will result in a decided reduction in the number of operations in stoneless gall-bladders.

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## ON PYLORIC STENOSIS AS A COMPLICATION IN CHOLELITHIASIS

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EXPERIENCE has long since taught us that vomiting and pain play an important part in the symptomatology of gall-stone disease. We also know the diagnostic importance, in many cases, of the interrelationship between these two symptoms: unlike what is commonly the case in gastric ulcer, vomiting does not usually occur at the climax of the regularly recurrent pains, temporarily easing these, but rather coincides with them in a disorderly manner without bringing about any amelioration. Besides this type of vomiting, however, vomiting occurs in rare cases of gall-stone disease as a sign of true residue in the stomach. Quite as in ulcer this is due to an organic pyloric—or duodenal—stenosis and demands, therefore, special considerations from diagnostic as well as therapeutic point of view. Papin, who, on account of a fatal case of his own, has dealt summarily with this complication—French authors seem on the whole more than others to have paid attention to this question—lays great stress upon the particular position that gall-stone cases with pyloric stenosis occupy just from the standpoint of surgical treatment.

The clinical picture presented here is to a certain extent characteristic. There is generally no question of a prolonged nor any very typical history of gall-stones. On the contrary the history is oftentimes remarkably short—one week to seven months (Friedmann's, Tuffier's, Papin's, and Venot's cases) and only exceptionally of a nature (*e.g.*, cases by Friedmann and Tuffier) that seems to point in the direction of gall-stones. Because of this and also from the generally somewhat advanced age of the patient and the debilitated condition as a result of vomiting, there is a tendency to more or less suspect cancer from the outset. Clinical examination reveals retention in a large, distended stomach. Not much is known about the character of the Röntgen findings: in Papin's case, however, it was noticed how the opaque meal passed the pylorus but accumulated in the duodenum especially in its distal part. It is the symptoms produced by the stenosis that bring the patient to seek help and which indicate operation.

The *pathological anatomy and pathogenesis* are of fairly great interest. Apart from cases where a gall-bladder, overfilled, particularly in its deeper parts, with stones is placed close to the pylorus or duodenum, and where a cholecystectomy alone causes the symptoms to subside, the following changes have been found in either the proximal or distal parts of the duodenum: 1. Considerable thickening and induration of the duodenal wall and compression of this between, on the one hand, the gall-bladder, widely and

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firmly adherent, and on the other the voluminous, abnormally firm head of the pancreas [cases by Gayet (published by Cotte) and Papin]. 2. Besides strong adhesions there may be a perforation, perhaps an obliterated fistula, between the gall-bladder and the duodenum in addition to one or more concretions in a pouch of the duodenal wall (case by Friedmann) or a wide communication between the gall-bladder and the duodenum may be occupied by a more or less voluminous stone inserted there as a wedge with one-half in the gall-bladder and the other in the intestine (Tuffier's, Okinczyk's and Goullioud's cases).

It stands to reason that the treatment in many cases must in the first place be directed toward the retention symptoms from the stomach. More particularly does this apply to patients with a much lowered condition where it is necessary to perform a gastro-enterostomy in a way that taxes the patient's strength in the least possible manner. Such cases have been related by Cotte (fatal issue) and by Venot (recovery). Tuffier did first a gastro-enterostomy (a tumor—"polypus"—was palpated in the first part of the duodenum), and at a second sitting he resected the pylorus and the aforesaid part of the duodenum as well as that portion of the gall-bladder adherent to it (in the specimen the "tumor" was found to have been a concretion located in a communication between the gall-bladder and the duodenum and protruding into the lumen of the latter). In one of Cotte's collected cases gastro-enterostomy was done first, followed at a second sitting by cholecystectomy (recovery); in one of Bircher's cases pyloroplasty and cholecystectomy were done at one and the same time. In the majority of other known cases the operation has consisted in cholecystectomy and gastro-enterostomy (possibly also duodenorrhaphy) at one sitting (one case by Friedmann, two by Bircher—recovery; one by Cotte—death) or cholecystostomy and gastro-enterostomy at one sitting (four cases by Cotte, of which two deaths) or in different stages (Papin's case, fatal issue). One finds that the nature of the pyloric stenosis is often only revealed after completion of the gastro-enterostomy and has then at times led to operation on the gall-bladder as well. Judging from the cases recorded in the literature the prognosis is serious; the technical difficulties of the operation are not infrequently considerable, and the interference most trying to the patient.

In the year 1913 I had for operation (No. 1:446, 1913; a woman, aged sixty-eight) where in addition to cholelithiasis and cholecystitis there was probably also a fistula between the deep, diverticular, strongly protuberant part of the gall-bladder and the duodenum. This, however, could not be definitely ascertained at the operation. At the operation—at which I was assisted by Professor Berg—cholecystectomy and retrocolic posterior gastro-enterostomy was done. In the suspected fistulous area a small part of the wall of the gall-bladder was left *in situ* in close contact with the duodenum; here three lines of suture were laid; first, one line involving only the margins of the diverticular remains, then a second one bringing the duodenum well over the first, and finally a covering with omentum. Recovery followed.

During the years 1917 and 1926, respectively, I had a case where the symptoms of pyloric stenosis were undoubtedly similar to those present in the above-quoted cases from the literature.

The patient from 1917, I:729, woman, aged sixty-seven, had on July 14 that year been taken ill with mild pains in the epigastrium. During the period July 19 to 21 she vomited blood repeatedly. Was admitted to the medical clinic on July 21, her general condition being then remarkably little affected. She was very tender on the slightest palpation of the abdomen, somewhat more in the upper part than the lower. The abdomen was slightly distended. The liver (?) could be felt one finger-breadth below the thorax in the nipple-line. Lungs, heart and urine normal. The vomiting continued daily up to July 27 inclusive. No brown discoloration of the vomit. Faecal specimens collected July 24-26, and on July 30 showed negative reaction on testing with Weber. *Röntgenological examination*, July 30: In upright position the opaque meal collects into the lower part of the stomach, the lower pole of which is in the small pelvis, the upper limit being horizontal. At the top of the duodenal bulb there is a gas bubble almost as large as a hazel-nut. Peristaltic waves gradually begin to appear in the fundus, proceeding toward the pylorus with even outlines. The gas bubble still remains on the top of the bulb, even during passage of contents through the descending part. The duodenum never empties completely. In recumbent position the peristalsis is considerably increased. The bulb never gets completely filled, and is distinctly tender on pressure. No defect or persistent depression of the stomach. A high intermediate layer is to be seen in the stomach. In prone position the duodenal bulb seems fairly well filled. Considerable residue after four hours. The gas bubble at the top of the bulb with sedimentation of the contents, the tenderness over it and the marked retention all point in the direction of a probable ulcer juxtapyloricum duodeni (Ström).

Patient was transferred to the surgical clinic on August 1, 1917. There had then been no vomiting since July 27 and the abdomen was neither distended nor tender. Below the costal margin one could feel a firm mass, not tender on pressure and with the surface and lower edge uneven. Test-meal August 2: Quantities of remaining currents, acid reaction, Kongo negative and Uffelmann positive. Never any raised temperature.

*Operation*, August 3 (Troell): Median incision in the epigastrium. Difficulty encountered in exposing the stomach partly owing to the lower edge of the great omentum being adherent in the small pelvis. The pyloric part of the stomach and duodenum the seat of a tumor, larger than a hen's egg, fixed and with difficulty movable. Impossible to determine its point of origin. The pyloric vein cannot be seen. It is covered, as well as adjacent duodenal portions, by firm, vascular adhesions and intimately united to the inferior surface of the liver and to the pancreas. The whole thing gives one the impression of cancer. Some glands as large as beans are seen in the great omentum. A posterior gastro-enterostomy is made in the usual way, somewhat obliquely, without loop and close to the pylorus where the ventricle adapts itself most conveniently to the jejunum. Nausea and vomiting during the three first days after the operation. Healing by first intention.

Test-meal August 17: Current-stones, total acidity 40, Kongo negative.

August 28: Patient who all the time has taken her food badly was to-day taken fairly suddenly ill with malaise. Vomiting supervened that seemed partly to be of faecal nature. There was also coughing with a moderate amount of tenacious sputum. No dulness over the lungs. Behind, especially on the right side, bronchial breathing and here and there fine, dry râles. Pulse very bad despite stimulants. Vomiting less severe toward the evening. The condition became rapidly worse and the patient died in the forenoon of the following day. *Patho-anatomical diagnosis*: Bilateral muco-purulent bronchitis plus bronchopneumonia of the left lower lobe plus cholelithiasis plus abscess after purulent perforating cholecystitis plus subcutaneous abscess in the operation wound

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(Ströman). The post-mortem report describes the changes in the operation area in the following words: In the region of the gall-bladder there is an abscess as large as a lemon, limited in front by a thin wall and behind separated from the kidney and the stomach by a thicker, membranous wall. At the bottom of the abscess cavity there is the thin-walled, torn gall-bladder and a nodular stone the size of a hazel-nut. The pus in the abscess was dark-colored, thin and turbid." The abdomen was in other respects normal, except for post-mortem changes in the liver.

The patient from 1926, I:675, woman, aged sixty-three, fifteen years ago had painful attacks off and on in the right side of the abdomen as well as jaundice. Gall-stone was diagnosed. Patient had not had any such attacks during recent years. In the autumn, 1925, there was a period of vomiting, apparently, however, of slight nature. Patient did not consult any doctor. Soon after Christmas, 1925, patient felt soreness and burning sensations in the epigastrium, and somewhat later (February, 1926) she brought up plenty of water in the mouth. Alternating with this she began to vomit, which symptom has lately become worse. At times vomiting occurred immediately after food, at other times later, and latterly also in the night. She wasted much in the spring, has not been jaundiced and has had no stomach-ache. Patient has sometimes recognized in the vomit food taken one or two days previously. *Condition June 2, 1926:* General state of health little affected. Heart and lungs normal. Abdomen not distended. No peristaltic movements are seen. From the umbilicus a somewhat tender mass, not fully defined, extends upward to the right. The liver not palpable. Blood: Hæmoglobin 90, red corpuscles 4.8 millions, white 12,000. Blood-pressure 125/70. Urine normal. Rectum examination nil. Test-meal: Numerous current-peals and stones on empty stomach, Kongo negative, total acidity 15, Uffelmann negative. *Röntgenological examination, June 7:* Stomach inconsiderably enlarged, of normal shape and well movable. Powerful stenotic peristalsis. The stomach shows everywhere even and soft outlines. No malformation. No palpable mass corresponding to any part of the stomach. No tenderness on pressure. After four hours almost total residue. The duodenal build does not fill up. It is a case of pyloric stenosis probably caused by infiltration of the pyloric wall (tumor ?) (Andrén).

*Operation, June 10 (Troell)* under the diagnosis of cancer of the stomach or possibly inflammatory tumor in connection with disease of the gall-bladder. Median incision in the epigastrium to two centimetres below the umbilicus. There was a remarkable amount of bleeding on incising the abdominal wall (more like that present in inflammatory processes than in cancer). The stomach is easily brought out through the incision wound and is not the seat of any cancer. Its pyloric portion, however, is strongly displaced toward the right and united, like the nearest part of the duodenum, to the altered gall-bladder and adjacent part of the anterior edge of the liver; this is here drawn downward and backward and the whole thing is matted together into a right-sided mass. This is felt to extend deep down as far as one is able to reach; it is impossible to determine whether it is a gall-bladder filled with stones or one having undergone cancerous changes. It seems most likely to be a question of gall-stones with cholecystitis and perforation of the gall-bladder wall downward toward the upper part of the duodenum, and perhaps also perforation of the duodenal wall; stenosis of the duodenum is certainly present. A couple of strong adhesions are divided between two ligatures. The fundus of the small, thick-walled, shrunken gall-bladder is then dissected free from liver and duodenum. One soon comes across a cavity with trabecular walls and pocket-like protuberances, containing numerous gall-stones. This cavity is evidently made up of the small lumen of the gall-bladder with a protuberance of large size directed downward; this has a narrow communication with the duodenal lumen immediately distal to the pylorus. The stones are removed (about one hundred of them as large as from hemp-seeds to twice the size of peas, faceted and with a cut surface consisting of a large black centre and a thin yellow peripheral area). Most of the gall-bladder is cut away. Cysticus and choledochus are not seen. After sufficient free-



ing of the duodenum from the adhesions far out to the right, the perforation in its wall is transversely closed with interrupted catgut, followed by silk sutures. A small Mikulicz's bag is inserted against the sutures and the remains of the gall-bladder; a large-sized Nélaton is also put in against the latter. Finally a posterior gastro-enterostomy is done with a fairly short loop. Before suturing the duodenal wall one discovered on its inner, posterior surface and in its longitudinal direction a papillomatous, tumor-like formation of the mucous membrane, 3 cm. long and  $1\frac{1}{2}$  cm. in height. The most proximal portion of this extends to the ventricular side of the pylorus; the tumor-like formation is removed. Patho-anatomical diagnosis: (a) The polypus from the duodenal wall is a simple mucous membrane polypus with inflammatory changes; in some places transitional, possibly stratified epithelium. (b) Parts of the gall-bladder: Chronic, inflammatory, hypertrophic changes (Professor F. Henschen). June 26: The wound having re-opened with exposure of the colon and other coils of the gut, a few mattress-sutures were put in, including most of the abdominal wall. After that slow healing. On discharge October 14 the patient's general condition was very good with no pains or discomfort after food. Röntgenological examination October 7: Gastro-enterostomy stomach with the gastro-enterostomy opening placed fairly high up on the fundus just above the sinus. The stomach empties partly through this and partly through the pylorus. The bulb is never completely filled up. Fairly satisfactory emptying of the stomach in different positions. There is a small quantity remaining in the stomach after four hours (Westermarck). Stated by letter of January 14, 1927, to be still in excellent condition.

The clinical course in these two cases conforms very nearly with most of the known cases of pyloric stenosis in cholelithiasis published in the literature. The first patient at the time of the operation had been ill for less than a month and did not seem to have had any symptoms up to that time pointing in the direction of gall-stones. The second patient had had attacks of gall-stone colic many years ago with jaundice, but had been quite well during recent years until symptoms commenced—about six months before admission to hospital—for which she now sought help. As in the first patient, these symptoms consisted almost entirely of vomiting which examination proved to be in the nature of retention. The primary indication for operation in both cases was a suspicion of cancer; the addendum to the report of the operation in the second case, "or possibly inflammatory tumor in connection with disease of the gall-bladder," was put down before the operation partly by reason of the earlier history of the patient, partly by her general condition being so relatively little affected. The Röntgen examination showed a high degree of pyloric stenosis as a result of—from what the findings seemed mostly to indicate—a juxtapyloric duodenal ulcer and tumor.

In the first case the operation itself gave no clue as to the nature of the condition. The pyloric part of the stomach and duodenum made up a tumor, larger than a hen's egg and adherent to the liver and pancreas that, on the whole, gave one the impression of cancer. Gastro-enterostomy was performed. After the lapse of three and a half weeks, however, patient became suddenly very ill and died; the immediate cause of death was pneumonia. The post-mortem examination showed the presence of a well-defined abscess, the size of a lemon, situated close to the stomach; the abscess was in direct communication with the gall-bladder by means of a perforation and



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contained a concretion as large as a hazel-nut; there was no perforation to the gut.

In the second case, as in the first, one found at the operation a tumorous mass firmly adherent to the liver, the nature of which it was first difficult to be certain of. It soon became evident, however, that one had to deal with a much changed, shrunken gall-bladder, containing numerous concretions and with the lower wall protuberant in a downwardly direction; this in its turn was found to be closely adherent to the duodenum with the lumen of which there was a narrow, open communication close to the pylorus. The inflammatory changes which had led to marked shrinkage had, through dragging of the pyloric region upward toward the liver and to the right, given rise to pyloric stenosis—a small polypus in the mucous membrane would not seem to have been of any real importance. This was clearly a case most reminding of Tuffier's, Goullioud's, etc.

It is improbable that the ultimate result in my first case would have been favorable had the treatment, beyond the gastro-enterostomy, been directed in some way or another, to the tumor itself. The chance of extirpating this seemed at the operation to be exceedingly slight; the whole thing gave one the impression of being a fixed, inoperable cancer. As an after-thought, however, it may be said that puncture of the tumor might possibly have given such information as to have led, for example, to cholecystostomy and evacuation of the abscess as supplementary measures to the gastro-enterostomy; this might have saved the patient. My handling of the second case was no doubt justified and correct. Similar procedure has previously been employed in two cases by Bircher (recovery) and in two cases by Friedmann and Cotte (both dead).

### SUMMARY

An account of two cases one of which gave, as it seemed, a long since passed history of gall-stones; the second case gave no such history. Vomiting in the nature of retention indicated operation in both cases which was undertaken in the first place because of suspected cancer. In the first case one found a gall-stone and a perforated gall-bladder, now in communication with an abscess, the size of a lemon, located between the liver and the stomach-duodenum; gastro-enterostomy was done but the patient died three and a half weeks later in pneumonia. In the second case numerous gall-stones were found in addition to a small and shrunken gall-bladder which communicated by means of a perforation in a protuberant part of its lower wall with the most proximal part of the small intestine; on account of traction upward and to the right, caused by inflammatory shrinkage, the pyloric region had become stenosed. After removal of the gettable part of the gall-bladder the duodenal wall was sutured and gastro-enterostomy done; patient recovered. While there are cases on record where symptoms of pyloric stenosis in cholelithiasis have been caused by patho-anatomical changes

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similar to those occurring in the second of these cases, there seems to be no earlier record in the literature of any similarity to the patho-anatomical findings in the first case.

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## ACUTE PERFORATION OR RUPTURE OF THE GALL-BLADDER\*

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ALTHOUGH acute perforation or rupture of the gall-bladder is not a very common occurrence, it is not so uncommon as is generally supposed. The purpose of this paper is to draw attention to it as a fairly frequent cause of the acute abdomen, as well as to the difficulties of diagnosis and the high mortality. Georg, in 1925, in a study of the literature for the last thirty years found 348 reported cases, with a mortality of 42 per cent.

This study is based on twenty cases of perforation or rupture of the gall-bladder occurring among the last 1000 cases of diseases of the gall-bladder and biliary tract admitted to the surgical wards of the Episcopal Hospital. In most instances the actual perforation was demonstrated at operation, but in a few no attempt was made to locate the perforation, the diagnosis being made on the presence of gall-stones or bile in the walled-off or free peritoneal cavity.

The series falls into two groups: Acute perforation into the free peritoneal cavity; and subacute perforation localized by adhesions. Eight of the series belong to the first group, *i.e.*, acute perforation without any attempt at walling off; and twelve to the second group, *i.e.*, sub-acute perforation well walled off by adhesions or omentum. A few instances of perforation of the gall-bladder into a hollow viscus—chronic perforations—are not included in this study.

*Acute Perforation.*—In the eight cases of this group six were males and two were females, their ages ranging from twelve to sixty-five years; two being under twenty, four between forty and fifty, and two sixty-five years of age. Three of them were suffering from typhoid fever when the perforation took place on the thirty-second, thirty-fourth, and forty-second day of the disease; two recovered and one died; the patients were all males, aged respectively, twelve, twenty-four and forty-two years. Of the eight, four gave a history of previous indigestion and one (the only one in the entire series) was a traumatic case. A brief resumé of the latter may be of interest.

The patient, a female, aged sixty-five years, was admitted to the Episcopal Hospital, service of Dr. Louis H. Mutschler, with a pistol wound of the right side (22 cal. steel-jacketed bullet). At operation, two hours after admission, the findings as reported on the operation sheet were: "Peritoneal cavity full of blood clots and free blood. Perforation of the lower portion of the right lobe of liver one inch from the edge. Bullet had passed through fundus of the gall-bladder, striking and fragmenting a gall-

\* Read before the Philadelphia Academy of Surgery, May 2, 1927.

stone. Perforation of the ileum, mesentery, transverse colon, etc." In addition to the intestinal repairs a cholecystostomy was done. The patient recovered.

*Diagnosis.*—As already indicated, a correct pre-operative diagnosis of a perforation or rupture of the gall-bladder is not common. In the present series the tentative diagnosis comprised: intestinal (typhoid) perforation, gangrenous cholecystitis, appendiceal peritonitis (one each), perforated duodenal ulcer (three), probable perforation of the gall-bladder (one). In other words, the true lesion was suspected in only 12.5 per cent. of the acute cases.

In the histories of this acute group the outstanding symptom that might lead to a suspicion of gall-bladder trouble was "repeated bilious vomiting"—noted in all but two—the traumatic case and one typhoid case. Some previous digestive trouble is also a common feature, five, *i.e.*, all but the typhoid patients, giving a history of gall-bladder indigestion. Jaundice, on the other hand, does not form part of the syndrome; in fact, it was not present in any of the acute group. The blood count is indicative of severe infection. In the typhoid cases it ranged from 6200 to 24,600, and in the others from 19,800 to 28,000. In the early stage the symptoms are highly suggestive of a perforated duodenal or gastric ulcer, and, as we have seen, that was the most frequent diagnosis in the acute cases. There is the same sudden onset of acute pain, marked abdominal rigidity, together with a previous history of indigestion. A large perforation with flooding of the peritoneal cavity with bile is probably accountable for the cases in the literature that were incorrectly diagnosed as intestinal obstruction or diffuse peritonitis. In the late stage of perforation or rupture, when a diffuse peritonitis has developed, confusion is even more apt to occur, and the most frequent diagnosis then is appendicitis with diffuse peritonitis or perforative peritonitis of unknown origin.

*Duration of Perforation.*—In the acute series the duration of the perforation was from four hours to three days. Of the three typhoid patients, two were operated on within five hours of the first symptoms of perforation, with one recovery and one death, while the third came to operation within twelve hours after perforation and recovered. The traumatic case has already been referred to, and of the four remaining cases two were operated on twenty-four hours after perforation, one recovery; the remaining two were operated on the third day after perforation, both dying. Thus we have a mortality of 50 per cent. (four out of eight cases). The operation consisted of cholecystectomy (two), with one recovery and one death; cholecystostomy (five), three recoveries, two deaths; simple peritoneal drainage (one), death due to peritonitis. Death was due to peritonitis in three and to myocarditis in one of the four fatalities. Stones were present in four of these acute cases, the traumatic and three others.

The bacteriological report on five cases was: Typhoid bacillus, one; bacilli, two; no growth, two.

## RUPTURE OF THE GALL-BLADDER

*Subacute Perforation.*—The group comprises ten females and two males, twelve in all. The age incidence shows a much higher average than in the acute cases, three being between thirty and forty, two between forty and fifty, two between fifty and sixty, four between sixty and seventy, and one over seventy years of age. Eight of the series gave a previous history of gall-bladder trouble of from two months to several years' duration.

*Diagnosis.*—In this second group it is not so difficult to locate the trouble as in the first one. Vomiting was the clinical symptom common to all, chills were noted twice, while jaundice was present three times, slight in two cases and very deep in the third. In the latter, at operation, a large stone was found impacted in the cystic duct. The white blood count in eight cases ranged from less than 11,000 (three) to more than 20,000 (five). A palpable mass was noted in six (50 per cent.).

Although a clinical diagnosis of perforation or rupture was not made in any of this group, the gall-bladder as the site of the trouble was noted ten times, the diagnosis being calculus or non-calculus cholecystitis; the other two were tentatively labeled high appendiceal abscess. It must be remembered that these subacute cases all came to the hospital several days after the inauguration of the acute onset, and with well-defined and localized symptoms, so that it was comparatively easy to recognize the gall-bladder as the site of the lesion. I believe that if they had been seen in the acute stage many of them would have been listed in a different category. Acute calculus cholecystitis, for example, during the height of the attack may be difficult to differentiate from a perforation. The most common condition producing a mass in the gall-bladder region is a distended, acutely inflamed gall-bladder plastered around with omentum. This is what four of the six cases of this series, with a palpable mass, were thought to be. Besides a high appendiceal abscess, two other conditions, a pericholecystic abscess and a subacute rupture of the gall-bladder, may give a palpable tender mass in this region. The mass of a pericholecystic abscess, however, when palpable, is exquisitely tender and is usually situated higher in the abdomen and nearer the midline than in the other conditions mentioned.

*Duration of Perforation.*—The approximate time elapsing between the symptoms of perforation and admission to the hospital ranged between four days (two cases), seven days (three cases), ten days (two cases), two weeks (three cases), and three weeks (two cases). Operation in this subacute group consisted of cholecystectomy in four cases, with one death; cholecystostomy in eight cases, with two deaths; either procedure thus giving a mortality of 25 per cent. The death after cholecystectomy was due to peritonitis, while following cholecystostomy one death was due to uremia and the other to pulmonary oedema. The bacterial findings in cultures in eight of this group were negative six times and positive for bacilli in two. One of the latter was the fatal case after cholecystectomy. Gall-stones were found in eight and bile only in the other four of this subacute group.



*Etiology.*—The chief etiological factor leading to rupture or perforation of the gall-bladder seems to be ulcerative cholecystitis, usually, but not always associated with the presence of gall-stones. McWilliams, in a collected series of 108 cases of spontaneous perforations of the biliary system, found stones present in 74 per cent., and Fifield found them in twenty-six out of twenty-eight cases reported from the London Hospital. In our series stones were present in 25 per cent. of the acute and in 75 per cent. of the subacute group. According to McWilliams, the mechanism of the perforation may be due to various causes: (1) Rupture from over-stretching, with or without the presence of stones; (2) pressure of a stone upon the wall causing ulceration; (3) gangrene due to (a) thrombosis of the vessels with or without stones; (b) cutting off the circulation due to pressure from a stone; (c) diphtheritic, ulcerative infection of the wall, with or without stone.

Mitman reports a case of chronic pancreatitis and ulcerative cholecystitis in which the gall-bladder ruptured, and attributes the catastrophe to increased abdominal pressure while straining at stool. Torsion of the gall-bladder, together with rupture, was reported to this Academy by Wendell in 1898.

Carcinoma as a cause of rupture of the gall-bladder is very unusual. Although Bonnet reports one case, we failed to find any case in our series in which malignancy was the etiological factor in producing the rupture, although the incidence of carcinoma of the gall-bladder was 1.3 per cent. in the 1000 cases of disease of the gall-bladder and biliary system.

Infection passing through the wall of the gall-bladder and producing a localized pericholecystitis or even a pericholecystic abscess is frequently met with, but it is rare for a diffuse peritonitis to develop in this way. Köerte has reported three such cases, while Richardson, Finsterer and others have observed instances in which bile was found in the free peritoneal cavity, but no perforation was demonstrable.

The cultures taken in both our acute and subacute cases bear out the work of Judd and his associates, and of Rosenow, Brown and others, that the bile does not offer any reliable data as to the presence or absence of infection of the gall-bladder wall and bacterial growth is inhibited by concentrated bile pigment, as shown by the experimental work of Drennan and others.

*Treatment.*—Successful treatment, as in every acute perforation of an abdominal viscus, depends largely upon early diagnosis and early operation. Perforation of the gall-bladder, however, differs from acute perforation of the duodenum, for example, in that it is infective from the beginning. This is well demonstrated in the cases that come to operation within a few hours after onset. Cultures taken from these may show a growth, while it is exceptional to obtain a positive culture from a perforated duodenal ulcer within the first twelve hours.

The question arises whether to do a cholecystostomy or a cholecystectomy.

## RUPTURE OF THE GALL-BLADDER

The ideal is to remove the gall-bladder, but as there is no time for study or preparation in these emergency cases, the choice will depend upon the duration of the perforation, the age, the general physical condition of the patient, and such laboratory data as can be obtained. Statistics seem to favor cholecystostomy. Our own series is too small to afford any deductions, but the mortality was alike, high, for both operations—fifty per cent.

The subacute cases present more time for study of the kidneys, the blood, the cardio-vascular system, and the little we know of the liver function. In the majority of instances these patients, after they have been carefully studied, can be leisurely prepared for operation so that they come to the operating table in much better condition than the acute ones.

If there is a large palpable mass and the incision is made directly into the same, I believe it is best to establish free drainage and nothing more. If necessary, a cholecystectomy can be done later. But if no mass is palpable, and the perforation is not suspected until the free peritoneal cavity has been opened, the mass having been carefully walled off with gauze packs, and it is found that the adhesions can be easily separated and the ducts exposed without difficulty, a cholecystectomy can be done, but it produces more trauma and opens up new avenues for infection and absorption, so that here also the deciding factors must be the laboratory data, the age of the patient and his general resistance, as far as this can be determined.

The obese patient with acute cholecystitis, especially if a female over fifty-five years of age with marked myocarditis, is the type of case that we know by experience is the more apt to develop acute dilatation of the heart or so-called liver shock. In such instances, therefore, a cholecystostomy, which takes less time and produces less trauma, is the better procedure.

### CONCLUSIONS

From the foregoing, it appears that the incidence of rupture or perforation of the gall-bladder is about two per cent. of the diseases of the gall-bladder and biliary tract. The reason it is not more frequent can be traced to several factors: The musculo-fibrous coat of the organ is quite dense and resistant, its lymph and blood supply is abundant, and finally the action of the bile on any organisms that may invade the gall-bladder wall seems to reduce their virulence.

Although several cases are on record, besides our own case, in which perforation of the gall-bladder resulted from trauma, beyond the fact that such an accident may happen to an organ lying so protected within the abdominal cavity, the chief interest, it seems to me, is the apparently innocuous effect of sterile bile on the peritoneum and the length of time a ruptured gall-bladder may be present without destroying the patient. This is shown by cases reported by Lane, Gare, Hildebrand, Fifield and others, and should be a great comfort to those who routinely close the abdomen in all cases of cholecystectomy.

May their patients' bile always be sterile!

EMORY G. ALEXANDER

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## SACRO-COCCYGEAL CHORDOMA

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TUMORS arising from remnants of the primitive notochord were considered a great rarity only a few years ago. The extensive work done on the embryology of the chorda dorsalis has led more readily to the identification and recognition of these tumors. Exhaustive reviews were written by Stewart (1922)<sup>12</sup> in England, Coenen (1925)<sup>4</sup> in Germany, Eckel and Jacobs (1925)<sup>5</sup> in the United States and finally by Stewart and Morin (1926).<sup>13</sup> These papers contain a complete bibliography with a thorough and detailed description of clinical, gross anatomical and histological features of these tumors. Although throwing no



FIG. 1.—Low magnification. View of tumor. Smaller and larger islands of tumor cells separated by connective tissue septa of varying thickness; small hemorrhagic areas in the left upper part, necrosis in the right upper portion. (X 60.)

new light on this subject we believe that our case should be added to the constantly increasing number of reports. It is of considerable interest to the pathologist and the frequency of its correct interpretation makes it a clinical problem of great importance.

### REPORT OF CASE

E. M., fifty-six years, white, male, married, salesman, was admitted to the surgical wards of the New York Post-Graduate Hospital on September 24, 1924, referred by one of us (Stewart), suffering of hemorrhoids and also complaining of the presence of a tumor in the sacral region. His father died of pulmonary tuberculosis; no other constitutional disorders were noted in the family. At the age of six he had pneumonia. Since then he has had no serious illness. In 1918, he was operated on for hemorrhoids. The tumor in the sacral region was first noticed one year before admission to the hospital and had slowly enlarged to its present size of a small orange. It at no time was

tender or painful. He had recurrence of his hemorrhoids, which bothered him for the last three months before admission, associated with occasional slight bleeding from the rectum. He wore a truss for a double hernia without discomfort. He denied any venereal infection. Examination showed an elderly, well-developed, well-nourished man. On the left leg varicose veins were found. A tumor mass was noted in the sacro-coccygeal region posteriorly, lying in the midline, of the size of an orange, fairly soft, oblong, movable under the skin, yet attached to the bone beneath, not tender. Rectal examination revealed internal hemorrhoids. A barium-colon enema with gastrointestinal X-ray series before operation was negative. He was operated on September 25, 1924; the tumor and hemorrhoids were removed. The tumor was adherent to the

periosteum with a deep honey-combed attachment; some difficulty was encountered in its removal but it was extirpated completely.

Our notes on the pathological examination of the tumor read as follows:

*Gross.*—The tumor is irregular in shape, soft in consistency, measuring 9 x 8 x 7.5 cm. To one side of it striated muscle fibres are attached. It is lobulated in structure, composed on section of a very soft translucent grayish-red mucinous tissue. It appears to be encapsulated in part by a fairly firm connective-tissue membrane.



FIG. 2.—Small islands of tumor cells invading the areolar tissue between the muscle bundles; some of these nests lie in close proximity to the striped musculature. (X 80.)

*Microscopic.*—The tumor is composed of islands of cells separated by strands of connective tissue of varying thickness. These islands or lobules are of various size; some reaching the diameter of 200 to 250 micra, others again are reduced to a width of 15 to 20 micra. Such smaller cell nests are composed of only three to four cells. The tumor is surrounded by a thick fibrous capsule around the greater part of its periphery. In one area, however, groups of tumor cells can be found in close contact with striped muscle fibres. The connective-tissue trabeculae show a rather mild degree of small round-cell infiltration. The blood-vessels—mostly thin-walled capillaries lined by flat endothelial cells—are dilated and filled with red blood-cells, leucocytes and lymphocytes. They are confined to the septa and do not invade the tumor parenchyma. The latter shows advanced degenerative changes. The cells are sparsely situated, separated by a homogeneous substance giving the mucin-reaction with specific stains. Small areas of necrosis and foci of hemorrhage can be recognized. In other areas, however, the cells are in close proximity to each other, closely set. The individual cells vary in size, shape and staining reaction considerably. There are small oval or rounded cells with finely granular eosinophilic protoplasm and small deeply staining nuclei. Others are larger, contain occasional vacuoles of smaller or larger size; the rest of their protoplasm is strongly eosinophilic; the nuclei are small and irregular. There are cells reaching a diameter of 40 to 45 micra, consisting of a nucleus either centrally located or pushed to the side compressed by one or several vacuoles, resembling a crescent, thereby giving the cells an appearance of a signet ring, such as is encountered in colloid carcinoma.



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Other huge structures appear to be protoplasmic remnants of such cells; the nucleus has disappeared, apparently as a result of pressure by the contents of the vacuoles. Many authors state that these vacuoles contain glycogen. We could not demonstrate its presence in our specimen. Some areas suggest a heavily vacuolized syncytium. Such physaliphores of varying size are characteristic for this tumor and have been traced to identical elements of the chorda dorsalis. The more compact cell aggregations show greater variation in size and shape of their elements. One observes small, deeply eosinophilic staining cell-structures with disproportionately larger nuclei and curiously mottled chromatin arrangement. Other larger cells with few vacuoles contain two to three nuclei of varying size. No mitotic division figures are found. It may be rather interesting to note that the centre of the tumor shows more advanced mucinous and other degenerative changes, whereas the cellular areas with irregular configurations are more frequent around the periphery of the tumor.

The diagnosis was sacrococcygeal chordoma.

The post-operative course was uneventful, the wound healing by primary union. The patient was discharged on October 4, 1924, in good condition. He was seen on several occasions since his discharge and appeared in excellent shape each time. He was last seen on January 13, 1927, in good health with no tendency to recurrence. No evidence of local recurrence or metastasis was found at any time. He had four treatments of deep Röntgen-ray therapy; the first application one month after operation; the second application two months after operation; three months elapsed before the third X-ray dose was given; the fourth and final dose was applied one month later.

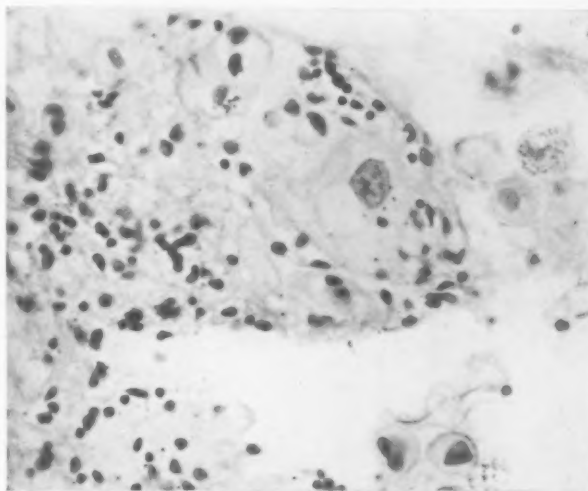


FIG. 3.—High-power photomicrograph. Note the variety of individual cells and their nuclei; a vacuolized cell with a giant nucleus slightly above and to the right of the centre. ( $\times 650$ .)

*Comment.*—Virchow in 1856, described soft, transparent, jelly-like nodules near the clivus Blumenbachii at the spheno-occipital synchondrosis, not exhibiting any active growth or infiltrative properties. He designated them as ecchondrosis physaliphora, prompted by following considerations: the nodules were always situated near the cartilage in a stereotyped relation to the latter; they were of a glassy, jelly-like consistency; they were often associated with an exostosis; finally he interpreted the physaliphorous cells as vacuolized cartilaginous corpuscles.

Müller<sup>8</sup> in 1856, however, wrote: "A direct relation of these growths to the chorda dorsalis cannot be overlooked and I consider them to be excessively growing remnants of the chorda. Whosoever likes the name may designate these masses as chordoid tumors or chordomas."

Müller's opinion could not prevail against the authority of Virchow and it was not until 1894 when Ribbert suggested to Steiner<sup>9</sup> to clear this problem,

that this growth was finally put into its proper place. Steiner proved conclusively that the soft clivus tumors were situated strictly in the midline; no transition from cartilage into the jelly-like mass could be observed, but the cartilage and mucinous tissues were lying next to each other; finally that the physaliphorous cells were remnants of the chorda.

Ribbert demonstrated the derivation of the chordomas from chordal remnants experimentally by puncture of the nucleus pulposus in the centre of the

intervertebral cartilaginous discs, thus producing tumors of identical gross and microscopic appearance.

From a survey of the literature one notices that chordomas were observed in following locations: (1) hypophyseal, (2) nasopharyngeal, (3) maxillary, (4) at the tooth of the epistropheus, (5) vertebral, (6) caudal. The latter ones were found: (a) antesacral, (b) retrosacral, (c) centrally within the bone.

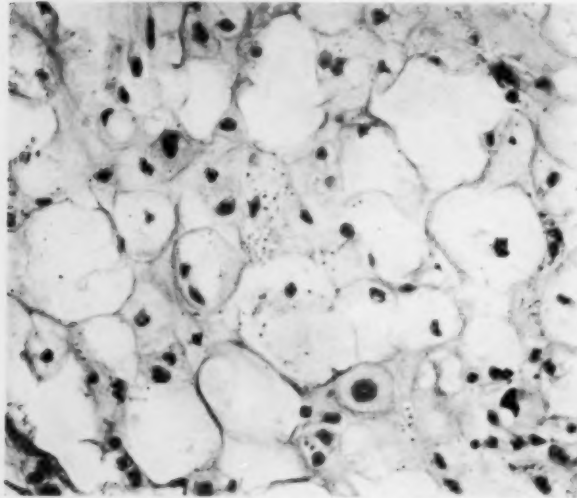


FIG. 4.—Another area. Large vacuolized cells, larger physaliphorous cells, signet ring forms and some syncytial elements, etc. ( $\times 650$ .)

They may be benign, such as described by Virchow and others under the name of ecchondrosis physaliphora, more correctly to be called ecchordosis physaliphora (Stewart). Most of them are malignant. The degree of malignancy varies, however. Many grow very slowly, are locally invasive, infiltrating the surrounding connective tissue or the musculature, sometimes destroying portions of the bone; recurrence is tardy, mostly local. Relatively few cases have been reported of either lymphatic or distant metastasis with rapidly fatal course.

Linck<sup>6</sup> in a thorough study on the development of the chorda dorsalis in the neck and head regions came to the conclusion that one can easily trace the undifferentiated, granular compact, eosinophilic, small vacuolar and larger physaliphorous cells of the chordoma from similar formations in the various stages of the development of the chorda dorsalis. In another paper on malignant sacrococcygeal chordoma to which is added a study of the development of the vertebral and caudal part of the chorda dorsalis, Linck and Warstat<sup>7</sup> state that during embryonal life there can be demonstrated in certain places along the course of the chorda, nests of apparently extruded chorda cells outside of the vertebro-skull basis anlage, which are in direct and close connection with the surrounding soft tissues. They may occur

# SACRO-COCCYGEAL CHORDOMA

dorsally and ventrally in relation to the vertebral column. These remnants may be considered as embryonic inclusions and are an additional support for Cohnheim's theory. Linck and Warstat conclude that chordoma may only occur in and be limited to portions where such persistent chorda cell-complexes occur outside of the axial skeleton. In their last review (January, 1926) Stewart and Morin collected fifty-seven cases. We would like to add the ones reported by Walz,<sup>15</sup> Sommer,<sup>11</sup> Cameron,<sup>3</sup> Argaud and Lestrade<sup>2</sup> since. Doctor Lederer in Brooklyn, New York, showed us sections of his case. This makes a total of sixty-three cases.

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**OBTURATOR HERNIA**  
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CASE.—J. F., age twenty-four, was admitted to the University of Maryland Hospital, March, 1923, having been referred by Doctor Metzel of the Medical Service. He had been operated upon for bi-lateral inguinal hernia sixteen years previously in York, Pennsylvania. Since that time he had complained of attacks of intermittent severe pain in the lower abdomen.

Examination showed scars from old operation. Abdomen was distended, very tender and painful over lower right quadrant. Rectal examination was negative. A definite diagnosis was not made because the patient was also suffering from illuminating gas poisoning, which occurred after first attack of pain four days previous. A tentative diagnosis was made of ileus, probably due to gas poisoning.

At operation by Dr. Arthur M. Shipley a loop of ileum was found in the right obturator foramen (Strangulated Richter's Hernia). No attempt was made to repair the hernial sac in the foramen because of the poor condition of the patient.

Convalescence was stormy for a few days. Patient was discharged from the hospital in three weeks following operation. Recurrence in two months. In the meantime patient suffered from pain, especially if on his feet much of the time. Pain radiated to his knee (Howship-Romberg Sign).

Second operation May 2, 1923. Right rectus incision. Right obturator foramen would admit the index finger for about three inches in length. The sac was sutured to the parietal peritoneum after pulling the apex of the sac through the foramen. Patient lived three years, apparently cured of the hernia, but died by drowning.

In 1724, Arnaud de Ronsil before the Academy of Surgeons of Paris described the first case of obturator hernia. Duverney also reported a case before this society he had found in the cadaver. Among other early observers have been Garengéot, Heuerman and Cloquet. In an article abstracted from the Museum Catalogue of St. George's Hospital, Stanley gives an account in the *Lancet* in 1850. He quotes the following, "Yet we are informed by Garengéot that Arnaud had reduced several obturator hernia and kept them up by bandages and he himself had seen and reduced two such cases of ruptures in the living subject, and two other cases had been communicated to the Academy."

Lawrence in his text-book in 1843 declares Garengéot's cases were the first proven cases of obturator hernia. Sir Astley Cooper also states in his text-book in 1843 that the only case he had seen was from a preparation in the Museum of St. Thomas' Hospital and unfortunately there was no history of the case. de la Garrenne reported a case in 1726 and Lecroissant reported a case in 1743. According to Erickson in the *Lancet* in 1850 the first case successfully detected and operated on with recovery was by Henry Obre although Hilton had opened the abdomen in 1847 for obturator hernia (*Med. Chir. Trans.*, vol. xxi, p. 326).

In addition to the case reported I have reviewed the literature up to 1909

## OBTURATOR HERNIA

## ABSTRACT OF CASES, 1909-1924.

Operator	Age	Sex	Foramen	How.-Rom. Sign	Operation	Result
Wagner, A. . . . .	72	F	Right	Negative	Laparotomy and femoral incision. Tube and ovary in sac	Cured.
Levit, J.:						
Case No. 1. . . . .	37	M	Left	Negative	Laparotomy resection of portion ileum	Death.
Case No. 2. . . . .	68	F	Left	Negative	Laparotomy recurrence in two months	Cured.
Case No. 3. . . . .	..	..	Right	Negative	Autopsy	.....
Van Zwalenburg. . .	76	F	Bilateral	Negative	Laparotomy recurrence in 9 years	Death.
Klopp. . . . .	88	F	Right	Negative	Laparotomy	Death
McMahon. . . . .	65	M	Right	Positive	Laparotomy and femoral incisions	Cured
Milligan. . . . .	..	M	Right	Negative	Inguinal incision	Cured.
Stones. . . . .	50	F	Right	Negative	Laparotomy, Richter's hernia	Death.
Richter. . . . .	46	F	Right	Negative	Laparotomy, Richter's hernia	Cured.
Sawday. . . . .	69	F	Left	Negative	Laparotomy, Richter's hernia. Resection	Death.
Davis and Eccles. .	59	F	Right	Negative	Laparotomy, Richter's hernia	Death.
Sohn. . . . .	60	F	Right	Positive	Laparotomy and femoral incisions, rt. tube and ovary in sac, side to side anastomosis	Cured.
Gunderman. . . . .	..	F	Left	Positive	Inguinal incision. Richter's hernia	Cured.
Case No. 1. . . . .						
Case No. 2. . . . .	65	F	Left	Positive	Laparotomy, secondary obstruction due to adhesions	Cured.
Franke. . . . .	72	M	Left	Negative	Laparotomy and femoral incisions	Cured.
Ebnother. . . . .	56	F	Right	Positive	Both incisions	Cured.
Plumplun. . . . .	65	F	Right	Positive	Both incisions, resection small gut	Cured.
Koennecke. . . . .	52	F	Right	Negative	Laparotomy, resection small gut	Cured.
Kindl. . . . .	..	F	Right	Negative	Inguinal incision, resection intestine	Cured.
Zora:						
Case No. 1. . . . .	70	F	Left	Positive	Laparotomy, Richter's hernia, resection gut	Cured.
Case No. 2. . . . .	54	F	Right	Negative	Femoral incision, Meckel's diverticulum in sac	Death.
Goebel. . . . .	68	F	Right	Negative	Autopsy	.....
Hohmeier, F. . . . .	60	F	Left	Negative	Laparotomy. Resection of intestine	Cured.
Case No. 1. . . . .						
Case No. 2. . . . .	60	F	Right	Negative	Femoral incision	Cured.
Rud. . . . .	..	F	.....	Negative	Laparotomy	Cured.
Gauthier. . . . .	54	F	Right	Negative	Both incisions, resection 15 cm. intestine	Cured.
H. R. A. . . . .	52	F	Left	Positive	Laparotomy	Cured.
Richardson. . . . .	51	F	Right	Negative	Laparotomy	Cured.
Stirling. . . . .	61	F	Left	Positive	Laparotomy	Cured.
Haines. . . . .	36	F	Right	Negative	Laparotomy	Cured.
Gelpke. . . . .	72	F	Left	Negative	Both incisions	Cured.
Keppich:						
Case No. 1. . . . .	53	F	Left	Negative	Femoral incision	Unknown.
Case No. 2. . . . .	..	M	Bilateral	Negative	.....	.....
Rawles. . . . .	83	F	Right	Negative	Laparotomy, Richter's hernia	Death.



ABSTRACT OF CASES, 1909-1924.—*Continued.*

Operator	Age	Sex	Foramen	How-Rom. Sign	Operation	Result
Marshall.....	..	M	Left	Positive	No operation	.....
Rischbeith.....	72	F	Right	Negative	Laparotomy, Richter's hernia, also had a femoral and sciatic hernia	Death.
Zinner.....	47	F	Right	Positive	Autopsy, Richter's hernia	Death.
Meyer:						
Case No. 1....	73	F	Bilateral	Negative	Autopsy	Death.
Case No. 2....	52	F	Left	Negative	Both incisions	Death.
Case No. 3....	70	F	Left	Negative	Femoral incision	Death.
Case No. 4....	82	F	Right	Positive	Both incisions, Richter's hernia	Death.
Case No. 5....	56	F	Left	Negative	Both incisions, Richter's hernia	Death.
Case No. 6....	58	F	Left	Positive	Both incisions	Death.
Klaus.....	70	F	Right	Positive	Autopsy	Death.
Kinscherf.....	47	F	Right	Positive	Femoral incision, Richter's hernia	Cured.
Steinneger:						
Case No. 1....	61	F	Right	Negative	Laparotomy, Richter's hernia	Death.
Case No. 2....	..	F	Right	Negative	Both incisions	Cured.
Mourier:						
Case No. 1....	66	F	Right	Negative	Laparotomy	Death.
Case No. 2....	70	F	Right	Negative	Laparotomy, Richter's hernia	Death.
Samarelli.....	52	M	Right	Positive	Femoral incision. Also had inguinal hernia	Cured.
Schoemaker.....	63	M	.....	Positive	Femoral incision, Richter's hernia	Death.
Van der Hoeven..	60	F	Right	Positive	Both incisions	Cured.
Kudlac.....	76	F	Right	Positive	Laparotomy	Cured.

with a detailed study of the cases reported from 1909 to 1924. Various men have reported groups of cases and there seems to be a discrepancy in the number of cases reported to date. The total number of cases on record varies from 250 to 400 according to different authors. From the Surgeons' Catalogue and the Index Medicus I find there has been about two hundred articles written on this subject and I have been able to find only 258 cases reported up to 1924. I believe there has been a repetition of cases in some instances and thereby making the number of cases on record as many as four hundred.

Since obturator hernia is no longer a rarity the mortality is gradually becoming less although it is still a little higher than the mortality of acute intestinal obstruction. If all cases be treated or managed as obstruction cases the mortality would still be less. If more emphasis be given to the Howship-Romberg Sign (pain on inner side of thigh radiating to the knee) and to the fact that a large number of them are Richter's herniæ, more correct diagnosis and naturally a lower mortality would result. Any case presenting the picture of intestinal obstruction with bowel movements would make one suspect an internal strangulation at the site of one of the smaller hernial rings, especially if there is no evidence of previous operation.

Many cases are confused or diagnosed as ileus or strangulated femoral hernia. If the latter can be ruled out then the operative procedure should be

## OBTURATOR HERNIA

through the abdominal route because we are dealing with an acute obstruction with a very high mortality. A complete operation can only be done by opening the abdomen. These patients are very ill and in many cases enterostomy may be the choice of procedure to get a live patient. Summers and Bonney have shown enterostomy is most effectual if done in the jejunum. This is one of the advantages of the abdominal route over the femoral. If a secondary operation be indicated in certain cases the osteoplastic flap of the pubic bone as described by Schwarzchild may be used.

In making a summary of the statistics in this group of cases, including the case reported herewith I find nine cases to be in the male, forty-five cases in the female and one case the sex is not given.

The age is not given in eight cases. Three cases were found between the ages of eighty and eighty-eight. Eleven cases were found between the ages of seventy and eighty, fourteen cases, between the ages of sixty and seventy, thirteen cases between forty and fifty, two cases between thirty and forty and the case reported was twenty-four years of age, the youngest case of the group.

A positive Howship-Romberg Sign was given in twenty cases, including the case reported, and given as negative in thirty-five cases. Sixteen cases were definitely described at Richter's hernia, two contained the tube and ovary in the sac of the hernia and one contained a Meckel's Diverticulum.

Thirty-three of the herniæ were in the right foramen, seventeen in the left foramen, three bi-lateral and in two cases the foramen was not given.

There were eighteen operative deaths, twenty-nine operative recoveries, five cases found at autopsy, and in three cases the result was not given.

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## ACUTE INFLAMMATION OF DEEP ILIAC LYMPH-NODES

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ACUTE inflammation of the deep iliac lymph-nodes is not common. According to a recent monograph of C. Lugones, Assistant Professor of Clinical Surgery in Buenos Aires,<sup>1</sup> who studied three cases in children of nine months, three and nine years of age, respectively, this condition may give rise to clinical symptoms that can lead surgeons to diagnose an acute intraperitoneal process. In all the three cases studied by Lugones, the inflammation was attributed to microbic metastasis following broncho-pulmonary infection.

According to Cunningham,<sup>2</sup> the deep iliac nodes are small but numerous. They lie on the lateral wall of the pelvis in front of the internal iliac artery and the ureter, and in the angle between the internal and external iliac vessels. Their afferents are: (a) the lymphatics which accompany the gluteal and sciatic vessels from the deep parts of the buttock and back of the thigh; (b) the lymphatics from the deep parts of the upper or inner portion of the thigh and the efferents of the obturator gland, and (c) visceral lymphatics from the lower two-thirds of the vagina, the bladder, the seminal vesicles and vas deferens, the prostate, the upper portion of the urethra and from the roof of the penis and clitoris.

In the absence of external wounds, and in view of their anatomical relations, it is easy to explain their inflammation in cases of acute or chronic inflammatory lesions of the rectum, vagina, prostate, seminal vesicles, etc. We have not registered metastatic inflammation of these nodes. In all four of our cases the origin of infection could be traced to inflammatory processes either of the posterior urethra, prostate or rectum. Colon bacilli, or associated strepto- or staphylococci and Koch's tubercle bacillus, have been the determining agents. As surgical treatment has not been attempted, we have not been able to ascertain the true nature of the pathogenic microbes and in mentioning the former bacilli, we have only relied upon the clinical symptoms and findings.

Symptoms usually appear gradually. First a slight painful feeling in the deep part of corresponding iliac fossa, which increases on sneezing, coughing or whilst passing stools. Gradually pain increases; slight or high fever sets in and patient takes to bed or consults a physician. When inflammation is severe, there may be a slight degree of peritoneal reaction, accompanied by hiccough, nausea, etc., and locally by a positive Bloomberg's sign. Dysuria was present in three of our cases. A constant and rather early symptom in all four cases has been the pain experienced at the end of micturition. This feeling may

<sup>1</sup> Lugones, C.: "Acute Adenitis of Deep Iliac Ganglia." *Revista Medica Latino Americana*, page 719, January, 1926, Buenos Aires, Argentine.

<sup>2</sup> Cunningham: "Text Book of Anatomy."



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range from a slight vague tenesmus to an excruciating painful sensation which may determine a reflex retention of urine as recorded in one of our cases.<sup>3</sup>

A slight numbness or tingling sensation may be felt along the whole lower extremity. Oedema of the thigh, leg and foot due to compression of deep iliac vessels and nerves may be present.

Compression of ureter may determine transient hydronephrosis or a gradual increase in backward pressure on the kidney accompanied by general symptoms in direct relationship with an increase in blood urea.<sup>4</sup> This influence may be greater in aged patients in whom there always exists a variable degree of nephrosclerosis.

Local inspection reveals rigidity of the corresponding half of the abdominal wall in its inferior quadrant. When nodes are largely inflamed, bulging of the anterior abdominal wall can be recorded in relation to the deep mass. Deep breathing produces a spasmodic contraction of the inferior segment of the corresponding rectus abdominis.

Palpation is of great importance. Complete relaxation of the abdominal wall must be tried. Sometimes inflamed nodes are better felt with the patient in lateral decubitus (affected side uppermost). When the size of the inflamed ganglia is very large, superficial palpation allows us to ascertain the existence of a tense, painful, immovable tumor in intimate relationship with the deep pelvic portion of the iliac bone. If the nodes have not fused and formed a confluent mass, deep palpation is necessary, and when pressing them against the osseous structure of the pelvis, intense pain is produced.

Rectal examination is of great importance. Laterally, to right or left, according to the nodes inflamed, a soft, pasty, painful mass can be felt. A difference in local temperature corresponding to the affected side can be recorded by the exploring finger. Combined bimanual, rectal and abdominal examination, may allow fluctuation to be ascertained if present.

In three out of the four cases that have come under our consideration, cystoscopy was practiced. In all we recorded a falling in of bladder wall toward its lumen and bullous oedema in relation to the part nearest the inflammatory process. Cystograms, in some cases both anterior and lateral, show clearly deformation of bladder shadow owing to its displacement by the neighboring mass.

Comparative diagnosis must be made with other acute processes either of right or left iliac fossæ. We shall only mention the most common, and therefore those which may lead surgeons to error. To the left we have (a) fecaloma, volvulus of iliac portion of rectum, acute spermatitis and strangulated hernia in all its varieties. To the right, the most common source of error may be acute appendicitis in a posterior descending vermiform. Comparative diagnosis with such a condition is very difficult as clinical symptoms are practically the same at onset. In such a case that came under our observation all

<sup>3</sup> Coutts, W. E.: "Acute Deep Iliac Adenitis. A Case Accompanied by Complete Retention of Urine." *Revista de la Sociedad de Urologia*, page 268, April, 1926, No. 9, Santiago, Chile.

<sup>4</sup> Chevassu, M.: "Les uremies curables." *Presse Medicale*, page 329, April, 1923.

the initial symptoms described for deep iliac adenitis were present, even to terminal stranguria. Operation revealed a descending posterior vermiform with adhesions to the bladder wall. It was only intense muscular defense which decided us to operate. Strangulated hernia and acute spermatitis must also be regarded as possible sources of error.

We shall now present the clinical histories of our cases and afterward discuss their treatment.

CASE I.—R. A., male, aged fifty years, enters ward No. 15 (Urological Department) of the Hospital Clinic, March 20, 1926.

*Hereditary Antecedents.*—Father died of tuberculosis; mother of cardio-renal disease.

*Previous Diseases.*—Grippe on various occasions. At the age of ten, amœbic dysentery. Since then he suffers of chronic constipation. He insists on never having acquired venereal diseases.

*Present Illness.*—A fortnight ago whilst working, general lassitude sets in, accompanied by nausea and a feeling of gastric fulness. No stools are passed, but there is abundant emission of gases. This condition lasts for five days, when he takes a saline purge and evacuates stools in large quantities. In the afternoon he discovers the existence of a painful tumor in the right iliac fossa and experiences slight stranguria. Pain at the end of micturition increases, rendering the passage of urine unbearable. Five days ago he suffers a violent retention of urine which makes catheterism necessary. General condition becomes worse; the slightest movement in bed arouses intense pain in the lower abdomen. Under these conditions he enters hospital.

*Physical Examination.*—Facies of intense suffering. Wasting condition is very marked. Skin is dry and pleats are easily made. Tongue dry and furry. Pulse is rapid (120 per minute). Temperature 39.6° C. in the rectum. Nausea and vomiting. Abdominal inspection shows a slight bulging of the anterior abdominal wall in its inferior portion to the right. Palpation reveals intense muscular resistance of lower two-thirds of rectus abdominis, more marked to right. Deep iliac nodes of this side are very large and tender to touch; they form a single mass which extends toward the median line.

Urethra is free in all its length to a No. 18 Mercier catheter. Urine obtained through catheter is somewhat cloudy but only contains very few pus cells. Testicles and vas deferens nothing particular. Rectal examination shows a small well-limited unpainful prostate. Toward right wall of rectum a soft, painful mass can be felt. Heart and lungs nothing of importance. Wassermann's blood test was negative. Owing to reflex troubles of micturition and to avoid patient further suffering, we decided to leave a permanent rubber catheter in the bladder.

During patient's sojourn in hospital, blood urea increases to 1.02 grms. per litre (29 III). On the 6th of April the quantity descended to 0.61 grms. per litre and thence sank gradually down to normal. Owing to high fever and general toxic symptoms we delayed cystoscopy till the 8th of April. Bladder holds easily 200 c.c. of liquid. Mucous surface normal in appearance in superior, inferior and left lateral walls. Right wall falls into bladder lumen and presents patches of bullous œdema. Both ureteral orifices are of normal aspect. After cystoscopy patient evacuates bladder spontaneously. A catheter passed immediately afterward allows us to ascertain the absence of residual liquid. On this same date we take two cystograms, one in anterior and another in the lateral position, using as contrast a 10 per cent. sodium bromide solution. Anterior cystogram shows clearly the displacement of vesical shadow due to neighboring inflamed nodes. Lateral view shows quadrangular shadow of deformed bladder due to compression of extrinsic mass.

Patient gradually recovers and leaves hospital in excellent condition. Three hard insensible masses are felt in relation to inflamed nodes.

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CASE II.—M. N., male, aged twenty years, enters ward No. 15 (Urological Department) of the Hospital Clinic, August 23, 1925.

*Hereditary and Personal Antecedents.*—No importance.

*Previous Diseases.*—Slight chills occasionally. Two years ago gonorrhœa for the first time. He disregards its treatment and six months afterward develops right epididymo-orchitis.

*Present Illness.*—Once acute inflammation of right testis declined, a small hard tumor remained in the caudæ, which two months later started to grow in size and ultimately opened spontaneously on the postero-inferior region of corresponding bursæ, giving rise to a fistula which persists up to the present.

In March, 1925, left caput epididymis suffers a similar process that broke out on the postero-superior surface of the corresponding bursæ. Simultaneously pollakiuria set in, most marked during the day time.

*Physical Examination.*—Patient of apparent good health. Urine cloudy, containing numerous pus cells. Urethra free in all its length to a normal sized exploring bougie. Slight difficulty in posterior urethra. Scrotum adherent to both epididymi, in intimate relationship with fistulæ which eliminate pus in large quantities. Both epididymi present irregular surfaces, due to existence of numerous painful nodules. Testicles are apparently normal. Vasa deferentia are hard and irregular. Rectal examination reveals an enlarged, uneven prostate containing numerous hard nodules. Liquid obtained after soft massage contains numerous pus cells, Koch bacilli (Ziehl-Neelsen), Gram-negative bacilli and staphylococci. Posterior urethroscopy (MacCarthy's cysto-urethroscope) shows deep tubercular ulcerations of verumontanum and surrounding tissues.

Heart and lungs nothing of importance. Radioscopy was negative as to tubercular lesions. Wassermann's blood test was also negative. Patient is submitted to a general treatment associated with subcutaneous injections of progressive doses of tuberculine, sun baths and iodoform paste locally.

General and local conditions improve rapidly and patient remains in the ward as helping hand.

In the first days of May, 1926, he complains of a troublesome sensation in the left iliac fossa. Dysuria accompanies pollakiuria. Three days afterward he takes to bed, with high fever, nausea and gradually increasing pain in the lower portion of abdomen. Temperature rises to 39° C. Local inspection reveals a soft, painful tumor in the deep portion of pelvis to the left. As symptoms are not well defined, he is placed under observation. Next day both local and general conditions are decidedly worse. The size of tumor has increased and he complains of a tense sensation in the whole of the left lower extremity. Peritoneal reaction is intensely marked. Rectal examination allows us to ascertain the existence of a pasty painful mass, which under bimanual palpation gives the impression of fluctuation. Fever is always high. We diagnose acute inflammation of deep iliac nodes, due probably to a tubercular process associated to pyogenic germs which have reached the nodes through the ulcerations of the posterior urethra. During the next few days the local condition remains *in statu quo*. Left inferior extremity increases its size to double. Arterial beat in the upper portion of Scarpa's triangle cannot be felt. Pachon's oscillometer needle indicates the absence of arterial pressure.

A cystogram, with a 10 per cent. sodium bromide solution in the anterior position, shows displacement of bladder shadow by an extrinsic mass. In a few days more, local and general symptoms subside rapidly. Fever descends and oscillates between 37.2 and 37.6° C. Lower extremity recovers its normal size and arterial beat can be easily felt even in the popliteal space. Arterial pressure is nearly normal.

Ten days afterward cystoscopy still allows us to ascertain a falling in of bladder wall to left and a cystogram shows bladder contour nearly normal, only to the left a

slight depression can be recorded. A fortnight afterward patient has renewed his usual work.

CASE III.—M. C., male, aged twenty-one years. Medical student.

*Former History.*—Of no importance. Never has acquired venereal diseases.

*Present Illness.*—On the 12th of April, 1926, and in absence of sexual intercourse, a slight urethral discharge is observed, accompanied by a slight burning sensation during micturition. Two or three days afterward pain in both thighs and slight swelling of superficial iliac nodes sets in.

In this state I examine him for the first time. Microscopical test of the urethral discharge shows pus cells in abundance and large quantities of micrococci. Urine is clear and contains some large mucous threads. Superficial iliac nodes are enlarged, painful to touch, but fluctuation is absent. Repose in bed and urethral treatment with a suspension of bismuth subnitrate in glycerine. Nodes do not improve under this treatment. He went to his home in Valparaíso. During his sojourn there the adenitis is surgically opened on both sides. Bacteriological examination of pus obtained only revealed the existence of common micrococci catarrhalis.

In a fortnight he returns and starts his medical course once more. A week afterward he suddenly feels a painful sensation in the right iliac fossa and pollakiuria sets in. Fever rises to 38.5° C. He also notices the existence of a deep, hard, painful mass to touch. Rectal examination shows existence of a large hard tumor in intimate contact with the right wall of the rectum. He remains in bed and two days afterward deep nodes to the left start inflaming. In a week's time he gets up and ten days later cystoscopy shows a falling in of both lateral walls of the bladder and a marked congestion of mucous surface to left.

Anterior cystogram with a 10 per cent. sodium bromide solution shows flattening of inferior wall. Lateral cystogram taken with same solution shows deformations of bladder due to squeezing between inflammatory masses.

CASE IV.—N. N., aged twenty-six. Physician.

*Former Diseases.*—In 1925 acute gonorrhœa complicated with left epididymo-orchitis.

*Present Illness.*—During the month of June of the present year he experienced slight trouble in the left iliac fossa which he attributes to his former inflammatory process of that side. Painful sensation is not persistent, but has intimate relationship with sexual intercourse. On July 13, after excessive sexual intercourse, pain starts once again, but of a severer character. On examination, one could easily ascertain the existence of a large, painful, deeply placed mass in the iliac fossa to the left. Marked resistance of abdominal wall and high fever. Rectal examination reveals a soft, unpainful prostate and an inflamed left seminal vesicle. Pollakiuria is intense and urine cloudy in both glasses. In this condition he is examined by other colleagues who diagnose the same condition, acute inflammation of the iliac nodes. After a few days in bed, associated with adequate treatment both of local and general conditions, he returns once more to his practice.

*Treatment.*—Refers to treatment of local and general conditions in relation to determining cause. Rest in bed and ice locally. Quinine, salipirin, etc., to bring down temperature. Saline laxatives to keep bowels free. Slight diet, milk and plenty of stewed fruits. Ichthyol enemas can be placed in the rectum. Where an Arzberger's canule can be procured, hot irrigations through the rectum are very helpful. In all cases we have employed vaccine therapy. Mixed staphylo- and streptococci, associated to colon bacilli vaccines have given best results. During convalescence general tonics are administered. Special attention should be paid to treatment of determining cause.

## COMPLETE RUPTURE OF INFRA-PATELLA TENDON AND ADJACENT CAPSULAR LIGAMENTS

BY LEWIS CLARK WAGNER, M.D.

OF NEW YORK, N. Y.

FROM THE THIRD SURGICAL DIVISION OF THE RUPTURED AND CRIPPLED HOSPITAL

A COMPLETE or partial break in the continuity of a muscle or tendon is not a rarity and in reviewing the literature it seems that this condition has been described with appropriate operative procedures or splinting for every important tendon in the human body except the infra-patella tendon. Tears in this tendon associated with fracture of patella or those instances in children in which the patella tendon is pulled from its insertion at the upper end of the tibia are excepted. I can find only one somewhat similar case as reported by Kreuscher.<sup>1</sup> The infra-patella tendon is described in anatomical works as that portion of the ligamentum patella which extends from the lower margin of the patella to its insertion in the anterior tuberosity of the proximal end of the shaft of the tibia. The anterior capsule of the knee-joint is formed by the collateral patella ligaments, which are the expansion of the vasti tendons and fascia lata on the lateral sides of the joint. The ligamentum collaterale fibulare is hidden within a covering derived from the ilio-tibial tract of the fascia lata. The medial expansion from the tendons of Sartorius and the semi-membraneous muscles augment the articular capsule, which then becomes continuous with the ligamentum collaterale tibiale.

The disruption of muscle substance is usually brought about by overstretching, as in lifting or carrying heavy objects, while tendinous breaks are usually associated with added muscular violence upon the already contracted muscular substance. The tear in the tendon most often occurs with the pulling off of its insertion along with its periosteal attachment or its junction to muscle substance, while it may occur through the main part of the tendon but



FIG. 1.—Shows patella pulled upward. Separation of patella tendon—V-shaped area of lessened density posterior to region of patella tendon.



one is led to believe that this accident only happens where there is some inherent weakness of the part affected. The break is never complete (Fig. 2)

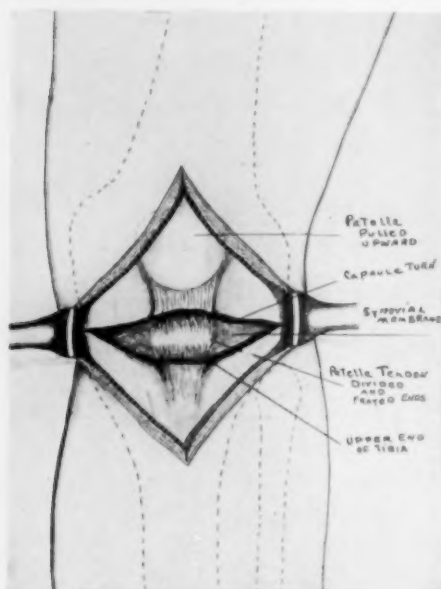


FIG. 2.—Shows tear through capsule and patella tendon with fraying of ends.

skin can palpate the interior of the joint. X-ray (Fig. 1) shows the V-shaped area of decreased density posterior to the patella tendon, which clearly demonstrated the divided tissues and completes the diagnosis.

*Treatment.*—It is well agreed that tears or separations of the smaller tendons only require splinting and rest, as pointed out by Stiell,<sup>2</sup> but an early operation is urged in the rupture of all the important tendons of the body to be sure of absolute restoration of function. The operation (Fig. 3) should consist of accurate approximation of the ends in order to restore normal muscle tone and can be held together by any sort of suture material that will not be absorbed before twenty days. The living suture material is not indicated except in large defects or when the ends cannot possibly be approximated. The limb is completely immobilized for at least forty days until

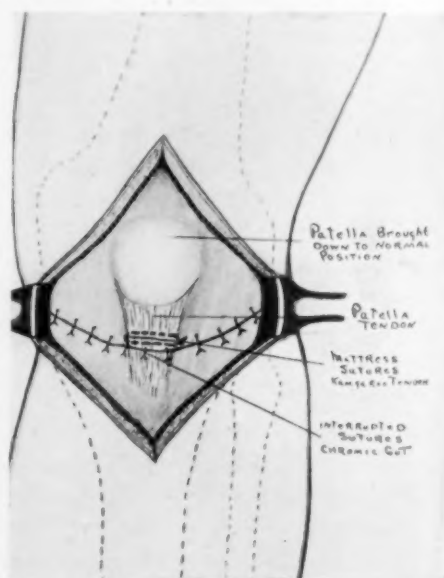


FIG. 3.—Repair completed and patella pulled down.

## COMPLETE RUPTURE OF INFRA-PATELLA TENDON

repair is absolutely certain, after which physiotherapy is instituted. The return to function is then rapid.

CASE REPORT.—Mr. G. S. P. K., age forty, has been very active all his life. On March 1, 1926, he slipped on a rug and in attempting to save himself from a fall, suddenly felt something snap in the left knee and fell to the floor. He was unable to rise because of the pain and inability to extend the left knee. He was seen two hours later. There was no pain except on attempting to move the left knee. Extension was lost. There was marked intra-articular and subcutaneous effusion. The patella was elevated and a distinct gap was noticed in the patella-tendon and the separation extended well around the lateral and internal condyles of the femur. The inside of the joint could be easily palpated, although the skin was intact. A diagnosis of rupture of the patella tendon with capsular tear was made and this was augmented by X-ray. (Fig. 1.) A tight bandage and posterior splint applied to stop the hemorrhage and the joint was put at rest. The knee-joint was explored the following morning and the tendon with the extensive capsule tear repaired. (Fig. 3.) The interior of the joint was normal. The leg was encased in plaster, which was worn for six weeks, at which time active motion and massage were started. The return to function was extremely rapid and at the end of four months patient was discharged cured with normal function and both knees measuring the same.

## LITERATURE

<sup>1</sup> Kreuscher, P. H.: Surg. Clin. of N. America, vol. iii, p. 1127, 1923.

<sup>2</sup> Stiell, F. W.: Practitioner London, vol. xcvii, p. 574, 1916.

<sup>3</sup> Shearer, R. K.: British M. L., vol. ii, p. 60.

<sup>4</sup> Waglotte, L.: Comp. Rend. Soc. de Biol., vol. xciv, p. 1130, 1926.

TRANSACTIONS  
OF THE  
PHILADELPHIA ACADEMY OF SURGERY

*Stated Meeting Held May 2, 1927*

The President, DR. CHARLES F. MITCHELL, in the Chair

EXPERIMENTAL SURGERY OF THE OESOPHAGUS

DR. GEORGE L. CARRINGTON, of Durham, N. C., by invitation, read a paper with the above title, for which see vol. lxxxvi, page 505.

The author said that the object of his work was first to get satisfactory anastomosis and then substitution. Mobilization of the stomach, pulling it up into the chest and resuturing it to the diaphragm is what the speaker has had in mind. Considerable care is required in the suture to the diaphragm or else hernia may occur and the dog die, if not promptly of dilatation of the stomach; then certainly a few weeks or months later. The mechanical part of such an operation can be handled, but the thing that worries one is the question of infection. Other surgeons interested in the chest have encountered the same difficulties. Some have had the experience of losing all the dogs operated upon and others feel that they can open the chest with impunity. Two workers, whom he has consulted, have had adverse experiences. One thought that dogs that came through without infection had had distemper and recovered, and those that died had not had distemper. Another had come to the conclusion that the pleura was very susceptible to infection. If the question of biological or chemical immunization can be worked out satisfactorily, the surgeon can then feel safe in performing many chest operations now seldom attempted.

PERFORATION OF THE GALL-BLADDER

DR. EMORY G. ALEXANDER read a paper with the above title, for which see page 765.

DR. JOHN H. JOPSON recalled that this subject was discussed before the Academy in 1913. At that time, several cases were reported. He himself had had two cases of acute perforation into the peritoneal cavity. In looking up the literature, the latest statistics at that time showed 50 per cent. mortality, which is about the same as at present. This winter he had a third case with certain interesting features—among others, the vomiting of blood. Doctor Jopson had been impressed with the fact that the cases seen of rupture into the free peritoneal cavity are cases in which the danger symptoms have been disregarded too long, not only by the physician but often by the patient, and it is a wonder that, treating gall-bladder cases as we do, the accident does not take place more often. Of course most surgeons hope

#### CHRONIC INTRACRANIAL HEMORRHAGE

to be able to tide the patient over the attack of acute cholecystitis until the acute symptoms subside. This is the speaker's practice. In a case outside the hospital or even in the hospital, he tells the consultant or resident that the continuance of intense pain will mean operation, even if the time does not seem suitable, because in his experience these are the cases which perforate. For example, the case this winter was that of an elderly man, who had had repeated attacks of gall-bladder disease. He was seen after he had been ill for a week and a diagnosis of probable empyema of the gall-bladder was made, pointing out to his physician that a recurrence of severe pain might indicate perforation. The following morning the patient vomited blood and was more or less collapsed. Operation was performed on the same day while in a desperate condition. The gall-bladder had perforated into the peritoneal cavity and a large number of small stones were found in the subhepatic space. These were scooped out as thoroughly as possible. A cholecystostomy was performed and subhepatic drains inserted. For a long while stones were washed out of the drainage tube. He finally recovered. The condition is akin to perforated duodenal ulcer as an emergency and in his opinion much more serious. The speaker expressed surprise that there were not more cases of the encapsulated type of perforation in the Episcopal Hospital series, as he had thought that they were more common than Doctor Alexander reported. There, cholecystectomy is usually the operation of choice.

DR. A. P. C. ASHHURST said that since the meeting to which Doctor Jopson refers, Dr. J. J. Buchanan, of Pittsburgh, before a meeting of the American Surgical Association, stated that he thought cases of biliary peritonitis without visible perforations were due to retroperitoneal perforations, and the bile trickled out through some aperture not seen at the operation. The fact remains that in a number of these cases, the surgeon declares he has seen bile "sweat" out of the gall-bladder. This bile can be wiped off. One condition which may be mistaken for a pericholecystic abscess is passive congestion of the liver from heart disease, and this should be borne in mind. The speaker was fooled once. The patient was a very fat woman, desperately ill, and with a tender mass in the gall-bladder region. The presence of cardiac decompensation was recognized but it was thought she was forming a pericholecystic abscess. Operation revealed a large blue liver. It was then realized that she had congestion of the liver from her heart lesion, and she died from the latter condition three days later. Another time, a patient was sent to Doctor Ashhurst by her physician with a diagnosis of gall-bladder disease. He thought she had only passive congestion of the liver and did not operate, this patient got well.

#### CHRONIC INTRACRANIAL HEMORRHAGE

DR. FRANCIS C. GRANT read a paper with the above title, for which see vol. lxxxvi, page 485.

DR. J. S. RODMAN said that generalized subdural hemorrhage is more

#### PHILADELPHIA ACADEMY OF SURGERY

common than localized but localized hemorrhage is notorious for its difficulty of diagnosis. Persistent irritating phenomena following trivial injury is at least suggestive of localized hemorrhage. The mortality is high and the speaker regards Doctor Grant's estimate of 25 per cent. as too conservative, believing that 45 per cent. is more nearly the average.

#### VITAL FACTORS IN THE MANAGEMENT OF PROSTATIC OBSTRUCTION

DR. B. A. THOMAS read a paper with the above title, for which see vol. lxxxvi, page 563.

#### TREATMENT OF BURNS

DR. WALTER ESTELL LEE and DR. WILLIAM MCCLENNAHAN (by invitation) showed a film of motion pictures illustrating the progress of a severe burn case. The film followed the case from the admission to the hospital, through the various stages of the treatment and finally to the autopsy at which a "Curling's Ulcer" of the duodenum was demonstrated.



# TRANSACTIONS

OF THE

## NEW YORK SURGICAL SOCIETY

*Stated Meeting Held May 11, 1927*

The Vice-president, DR. FRANK S. MATHEWS, in the Chair

### RUPTURE OF SPLEEN AND DIAPHRAGM, HERNIA OF STOMACH

DR. CHARLES E. FARR presented a boy twelve years of age, who entered the New York Hospital, Service of Dr. Charles L. Gibson, First Surgical or Cornell Division, April 19, 1927, with the history that he had been knocked down and run over by a taxicab immediately before admission. He was not unconscious but had pain and considerable shock.

Examination showed a slight bruise over the left costal margin and similar bruises over the pubis. None of these were conspicuous nor of any size. On admission pulse was 101. Temperature, 98.2. Blood pressure, 110/70.

There was some tenderness and slight rigidity of abdomen. He vomited once. He was kept under observation for ten hours and given a glucose infusion. His condition seemed fairly good, although the blood-pressure remained low. He was definitely anæmic, as if he were losing blood.

Just before operation, patient showed a curious dullness in the left thorax in the axillary line with a tympanitic area below that and dullness in the left hypochondrium, X-ray was taken and a fluoroscopic examination was made. These showed a large bubble of gas in the left side apparently below the diaphragm, and the diagnosis was made of ruptured viscus, probably the stomach, with free gas in the peritoneal cavity. Unfortunately, in the pressure of work, the X-ray film was not carefully examined, as the correct diagnosis would have been easily revealed.

Operation was performed about eight hours after the injury under ether anæsthesia. A left split rectus incision aided by a transverse incision to the left gave ample exposure. The abdomen was found to contain a very large amount of free blood, both clotted and fluid, and the spleen was lacerated along its inner and posterior margins and was apparently still bleeding freely. At this time it was first noticed that the stomach was not in the field of operation. By traction on the colon the stomach was brought down and a pronounced whish of air announced a rent in the diaphragm. The child's condition at this time was desperate. It was deemed essential to remove the spleen. A pack was inserted across the opening in the diaphragm and the spleen removed with but moderate difficulty. There were many adhesions to the diaphragm, which made delivery of the spleen somewhat tedious.

Examination of the rent in the diaphragm showed a clean cut tear 10 centimetres in length extending from the œsophageal opening toward the left. At each attempt to repair this opening, the child became extremely cyanosed, ceased to breathe, and the pulse became almost imperceptible. With fingers inserted in the opening, the gush of air allowed restoration of equilibrium in the thorax and the child's condition improved. It seemed impossible to repair the damage with any degree of safety. A Gibson-Mikulicz tampon was inserted between the stomach and the diaphragm and a rapid closing of the abdominal wall carried out. The child rallied well, received one transfusion, and has made an uninterrupted recovery, although he ran a slight temperature for several weeks after the operation.

# NEW YORK SURGICAL SOCIETY

The post-operative blood counts have been complicated by the resultant irritation of the wound and a mild pleuritis, apparently aseptic. This, with the splenectomy, gave the following counts:

Date	R. C.	Hemo. Per cent.	W. C.	Poly. Per cent.	Lymph. Per cent.
4/19	3,952,000		18,000	86	14
4/19			31,200	92	8
4/20	3,984,000	75	19,300	80	20
4/21	4,368,000	80	20,700	76	24
4/22	3,452,000		15,000	79	21
4/23		70			
4/25	4,200,000	84	16,200	82	18

Post-operative X-ray examination apparently showed the stomach still retained in the abdomen and a large air bubble in the thorax where the stomach had been. Later examination, however, with the introduction of a little barium mixture, showed that the stomach had become almost entirely a thoracic organ.

The child seems in no distress and certainly is not in condition to withstand an operation for repair of the rent in the diaphragm at present, as his pulmonary capacity must be greatly diminished. There is always some danger of volvulus of the displaced stomach.

This is the only case of lacerated spleen, ruptured diaphragm and herniated stomach that the reporter had been able to find in the literature. In the May number of *Surgery, Gynecology and Obstetrics*, there is a report of a similar injury to a boy nine years of age with a lacerated diaphragm and hernia of the stomach, spleen and colon. This was diagnosed previous to the operation and was cured by a trans-thoracic operation.

## SUPPURATIVE ARTHRITIS OF KNEE

CASE I.—DR. CHARLES E. FARR presented a girl, six years of age, who was admitted to St. Mary's Free Hospital for Children, February 14, 1921, suffering from a stiff and swollen knee, the result of a fall down stairs six weeks before. She was able to walk about. The swelling on the sides had subsided but "came to a point" in front. It had been opened by the family physician and considerable pus evacuated, apparently from the bursa. The family and past history were negative.

Examination showed a somewhat anæmic girl with large tonsils. There were no other findings except the surgical condition. The right knee was swollen, entirely in front of and apparently superficial to the patella. Small drainage wound; skin cyanosed. Function of knee impeded by swelling, but not to any great degree. Temperature 100°. Pulse 104. There was a sub-fibrile temperature for five weeks and then it shot up to 104° and became septic in type, remaining so for four weeks. Von Pirquet test positive.

Operation, March 2, 1921, for better drainage showed no necrosis of patella, possibly tuberculosis. X-ray suggested tuberculosis.

Microscopical examination showed only granulation tissue in abscess wall. A second specimen showed chronic inflammation.

Cultures from throat, nose, ear, yielded streptococci. Culture from knee, staphylococcus aureus.

The knee became stiff but there was no complete bony ankylosis.

She was re-admitted November 5, 1922, and remained until October 18, 1923. A resection of the knee was performed for deformity and pain, as the knee was nearly completely stiff in a flexed position. At operation, the cartilage was badly eroded but there was no evidence of tuberculosis.

## SUPPURATIVE ARTHRITIS OF KNEE

Microscopical examination of the bone and cartilage removed showed a suppurative arthritis, not tubercular. The child was lost sight of after leaving the hospital and was re-admitted February 16, 1927, with a marked varus deformity and apparently bony ankylosis. An attempt was made to correct the deformity by osteotomy of the tibia but when a little force was used the joint opened again leaving a large gap between the tibia and the femur. After a few weeks' rest in plaster, the operative wound was re-opened and a bone graft taken from the middle of the tibia. The original osteotomy wound of the tibia was separated freely and the bone graft driven in transversely. This forced the internal tuberosity of the tibia into contact with the femur. Primary union occurred. The bone has consolidated and the knee is now fairly straight. It is being kept in plaster until firm ankylosis occurs.

It is probable in this case that a further varus deformity will occur if the internal condyle of the femur does not grow in correspondence with the external.

When the child attains her full growth it will probably be necessary to do another osteotomy and insert another bone graft. In this way the length of the leg is somewhat increased, but, of course, not up to the length of the left leg. It may be possible in later years to do an arthroplasty and obtain a movable joint.

This case is shown to illustrate the destructive effect of a septic arthritis in which the Willm's treatment could not be applied.

CASE II.—DOCTOR FARR also presented a case of suppurative arthritis in a woman, forty years of age, who entered the New York Hospital, Service of Doctor Gibson, May 31, 1926, suffering from a perinephritic abscess of staphylococcus origin. She was operated upon for this and made an excellent recovery. During the convalescence she developed a phlebitis in the left femoral vein. This was followed by a typical suppurative arthritis of the left knee, presumably metastatic. About the third day after the first observation of swelling and pain in the knee, aspiration revealed thick pus containing the staphylococcus aureus. Under ether narcosis two long lateral incisions were made into the knee-joint evacuating a large amount of thick yellow pus. No drains and no sutures were used. A light moist dressing was applied and the Willm's method of treatment instituted immediately. The woman was very coöperative and made steady progress in spite of her perinephritic wound. The joint healed in about three weeks and the skin wounds within two months. She is presented as having made a complete recovery from a very severe suppurative arthritis. Motions are normal. There is no creaking in the joint, no pain, and she can walk as well as ever.

An interesting feature in this case is that she is the fourth member of the family to suffer from a severe grade of staphylococcus aureus general sepsis, three of her children having had osteomyelitis; one of them also had a suppurative arthritis of the knee and made a complete recovery.

The Willm's treatment for suppurative arthritis of the knee yields perfect results if it is instituted early and carried out effectively. It will not give such results where actual destruction of joint cartilage has occurred, nor will it give such results where it is impossible to institute early active motion.

CASE III.—DOCTOR FARR also presented a man thirty-two years of age who was admitted to the New York Hospital, July 9, 1926, complaining of painful and swollen joints of twenty-four hours' duration. On the day of admission, the pain in the right knee became very acute. The left ankle was also very tender. On examination, the right knee was very swollen, very painful on motion, and tender to touch. During the day, the swelling increased rapidly and became more painful. The pain was increased by motion. The family

and past history was negative. The patient had had his tonsils removed several years before. He had had no rheumatism and no joint troubles. There was no history of cardiac, digestive, urinary, nor venereal disease.

Physical examination revealed a slightly coated tongue, teeth in fairly good condition, tonsils large, congested and cryptic. There were a few scattered acne pustules. There were no enlarged lymph-nodes. The external genitals were normal. The right knee contained a moderate amount of fluid. There was a definite patella click. Tenderness and swelling were moderate. The left ankle-joint seemed tender but not swollen. Two days after admission, the left ankle had cleared up. The right knee was considerably swollen, and aspiration revealed purulent fluid. Two days later, he was transferred to the surgical division, service of Doctor Gibson, and the point was freely opened by two artero-lateral incisions, each three inches in length. A large amount of yellow fluid escaped under pressure. No drains inserted. We had not been able to carry out Willm's method, although conscientious efforts were made in that direction.

Convalescence was uninterrupted. The wounds healed by granulation. He was discharged on the nineteenth day, with the wounds partly granulated. He had attained a range of about 35 degrees of motion on discharge from the hospital.

Two days later, he was re-admitted because of increased swelling and rise in temperature, evidently due to too early closure of the incisions. The wounds were re-opened under anæsthesia, many adhesions being found. Following operation, the drainage gradually ceased and active motion was continually urged. On the third post-operative day he could walk well on the leg with full extension and 110 degrees of flexion. He has made excellent progress since and he has been able to follow his usual occupation.

This case is presented as one in which too early closure of the joint wounds occurred, but even with this setback, the result is very satisfactory.

Repeated cultures from the knee gave no growth. The nature of the infection remains unknown.

Examination at the present time shows perfect function and no signs of synovitis.

#### CARCINOMA OF RECTUM

DR. CHARLES E. FARR presented a woman, thirty-one years of age, who entered the New York Hospital, complaining of loss of weight, strength, pain in the lower abdomen, constipation and blood in the stools. She had lost thirty pounds.

Examination showed a vigorous woman in excellent general health but evidently suffering greatly from the toxemia accompanying cancer of the rectum. This was about four inches from the anal margin and involving the uterus, which was still movable in the pelvis.

March 12, 1926, under local infiltration of the abdominal wall and sacral anæsthesia, the combined operation was performed through the left rectus incision.

The mass, although extensive, was removable, and there were no apparent metastases. A permanent colostomy was established in the left loin. The lower segment of sigmoid was freed down to the rectum and dropped into the pelvis. Through a perineal incision, including also a vaginal extension, the entire anal region, rectum, sigmoid, and uterus were removed *en masse*. This growth was near the limit of operability.

The woman made an excellent recovery after a transfusion. There was little or no infection. She returned home in about three weeks and has been in



## CARCINOMA OF BREAST

excellent health since. She had four deep X-ray treatments at various times since the operation. There has been a leak of urine into the vagina of greater or lesser degree for long periods. This has completely dried up, and then from over-exertion or neglect to empty the bladder, the sinus re-opens. She has gained thirty-five pounds and seems perfectly well. The artificial anus has a very marked tendency to cicatricial contraction and has to be dilated occasionally.

The microscopical report was ulcerating adeno-carcinoma.

## CARCINOMA OF BREAST

CASE I.—DR. HUGH AUCHINCLOSS presented a woman, age forty-nine years, who entered the Presbyterian Hospital in December, 1917, because of a lump in the upper part of her right breast. There was also very definite retraction of the skin over it. Small nodes were palpable in both axillæ. There were small areas of induration in various portions of the left breast none of which were manifestly suspicious of cancer. X-rays of her chest and bones were negative.

A very wide skin excision and extensive fascial dissection was done removing both pectorals, axillary contents, the vascular anastomoses between the intercostal and subscapular branches, and skin grafting the uncovered chest wall with Thiersch grafts. Thirteen days later she returned home.

The pathological report was carcinoma. Attention was called to many mitoses present and to the markedly involved axillary lymph-nodes.

Five months later the left breast was removed because some of the areas of induration had changed so that it was impossible to be sure that the disease had not extended to that side. The muscles and axilla were not dissected. No evidence of cancer was found, however, only the lesions of a chronic cystic disease. She was given radiotherapy by X-ray for a short time after operation but none in recent years.

Beyond occasional times when apical signs suggestive of pleural tuberculosis have been noted, this woman, who showed extensive axillary metastases and a rather large primary tumor, has remained apparently quite well over a period of nearly ten years.

CASE II.—A. F., married, entered the Presbyterian Hospital in March, 1916, because six months previously she had found a lump she described as the size of an olive in the lower outer quadrant of her right breast. She felt well and had lost no weight. A firm lump, situated about half way between the skin and the chest wall, measured a little over an inch in diameter, was noticeably freely moveable, seemed spherical, suggesting encapsulation, and lay beneath skin that moved freely over it. It couldn't be seen and no retraction sign was demonstrable standing, lying down, or on lateral inclination. But on bending far forward, with arm outstretched, and pectoral muscle taut, it was possible to detect the faintest, yet definite, flattening of the breast contour. One node in the axilla felt unusually firm and was considered clinically suspicious. There were no evidences of chronic cystic disease elsewhere in either breast.

A thoraco-mammary incision with excision from posterior aspect of a sector-shaped area, including the mass, was done. It was, grossly, and by frozen section, carcinoma. A wide skin excision fascial dissection, with pectoral muscles, axillary contents, and rectus sheath removal was done, and the wound skin grafted. Subsequent examination of the tissues showed the axillary lymph-nodes contained metastases. She went home thirteen days later. It is now about eleven years since operation and she is apparently quite well.



Operations of a less radical nature may prove adequate in cases where the disease has remained local. When the disease has begun its march through the adjacent lymphatics the most radical procedure possible would seem indicated. No one can tell when this spread has begun or how far it may have gone in any case. Just what the factors may be that are associated with follow up results of long duration aren't known, but very radical removal may be, and not unlikely is, one of them. These two cases demonstrate that cases with axillary metastases well established may remain well for a long period of time after a wide, radical removal. It is difficult to believe that operation did not play some part in their remaining well, and if they had had no operation it is hard to believe they would be alive to-day. Yet, many still contend that people with cancer of the breast are doomed and are just as well off without operation.

#### LATE RESULTS OF OPERATION FOR CARCINOMA OF BREAST

DR. WILLIAM CRAWFORD WHITE read a paper with the above title for which see page 695.

DR. JAMES I. RUSSELL considered that there was a distinct advance in the work done by the group at Roosevelt; they have taken up the work of Greenough and, quite independently, have conscientiously worked over these cases, a number of which he had been privileged to see and on some he had operated. Although it was a splendid thing to see these cases that had remained well for ten years, he did not believe it was yet known what time to say a case is cured. He had seen one case come back twenty-five years after operation with a local recurrence in the skin and she eventually died, thirty years after operation, of pleural metastasis. To the speaker's mind, carcinoma, irrespective of how wide the dissection or how careful the operation, has a doubtful outcome. It acts differently in different individuals; some look quite malignant under the microscope and yet it is extraordinary how long they will go without recurrence. The age incident has its influence; the older they are the better chance they have of dying of something else.

DR. HUGH AUCHINCLOSS said that the most radical operation possible is plausible because of the principle that underlies it. Operation is being done to remove cancerous growth spreading in all directions and the surgeon should then and there take the opportunity to do as much removal as the individual can stand, and should choose those paths that are the ones along which this disease travels preëminently. In regard to the skin incision recommended by Handley the speaker could not agree with Handley's recommendation in this respect.

The vascular routes, blood and lymphatic to and from the internal mammary vessels and nodes lies very close to the skin surface. There are plentiful communications between these vessels and those in the breast tissues. Indeed metastases in the region of the perforating vessels close to the sternum often are apparent in the intercostal spaces so that the routes from the breast to these glands cannot be cut with safety. Undermining close to the skin as

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Handley recommends is most desirable, but the nearer one approaches the nipple zone the nearer are these vessels to the skin. Accordingly, as wide skin removal as possible followed by undermining close to the skin, offers a safeguard, the more conservative operation does not.

Doctor Halsted felt very strongly on the subject of skin removal and so expressed himself in a personal conversation Doctor Auchincloss had had with him the last year of his life in Baltimore.

The rectus sheath removal is another semi-theoretical thing. One hardly dares not remove it at the present time. The speaker had never seen carcinoma in the rectus sheath until this year. It was a case in a young woman of chronic cystic disease with extensive papillary proliferation into the cysts in which the breast tissue had been removed but the nipple left in because there had been no evidence of carcinoma on careful microscopical examination. Several months later, however, a lump appeared in the areolar region that, on excision, was found to be carcinoma. Many months afterward the patient had an area of carcinoma in the chest wall. Because she seemed so well in other respects and on the chance that it was a local manifestation this was removed with three ribs and their cartilage and about three-fourths the width of the sternum corresponding. It was found that the growth had involved the pleura, which was then excised so that the pericardium and mediastinum lay bare. Just before she went home, however, another metastasis was found in the chest wall. It had extended to the posterior surface of the pericardium to the lung and over the pleural surface of the left leaf of the diaphragm. It was taken off the pericardium and the lung and from the accessible part of the diaphragm. On cutting across the rectus muscle, however, a cord-like strand of carcinomatous tissue ran through the sheath and into the rectus muscle. That is the only case in which the speaker has ever seen carcinoma in the rectus sheath.

About the technic of removing a specimen for frozen section: It is difficult to tell what to do. One has to employ different methods in different cases. There are cases where the lump is close to the skin and one thinks it is carcinoma but is not sure; in such a case it may be well to make the smallest amount of trauma and cut directly into the growth.

In other cases where there is a broader and deeper area of induration it may be wiser to wholly excise the area and make a search through all parts of it.

There is a definite group where though one lump may be under suspicion, there may be several other lumps in other parts of the breast. The lump under suspicion may be excised and extensive papillary proliferation into the ducts found. This diffuse, papillary proliferation into the ducts must always be regarded with concern, especially when the papillary in growths are lined by cuboidal cells with scant cytoplasm and not the high, pale, so-called "Blasse Epithelzellen" of chronic cystic mastitis. Removal of the breast and search for carcinoma is the safer procedure in such cases.

The lump under suspicion may not be the lump that contains the carcinoma

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in some cases. In one case, after removal of the suspected lump which was found to be made up of these dilated ducts filled with cuboidal cells forming papillary processes, the breast was removed. Two centimetres away from the sector-shaped area that had already been removed was a small carcinoma that none of the physicians who had seen the case had noticed at all, and in one node in the pectoral group of the axillary nodes was a metastasis. A third operation was then begun under the same anaesthesia and a widespread radical removal done.

One cannot depend too much on statistics in breast carcinoma, for there are no statistics where are included all the varying factors that go to make statistics tell the whole truth available. The lessons to be learned from statistical tables are by no means always the true lessons. The striking things that occur in two or three cases may teach one more than a host of statistics, no matter how conscientiously compiled.

DOCTOR WHITE, closing the discussion, said that all of the cases who died were considered to have died of carcinoma, and even at the ages of seventy-nine and eighty-two were reported to be carcinoma deaths. He had given the results of the moderate operation practiced by many surgeons as against the radical procedure done by others. He felt that the latter should present similar statistics in order to prove that it is worth while to subject the patient to more severe procedures. The claim that they have no skin recurrence with the radical operation is very interesting and Doctor White wondered how could be explained a case that had recurrence of the skin after sixteen years and died of pulmonary metastasis the following year. Doctor White was sorry that no one spoke of the X-ray therapy as he would like to know if anyone has definite information as to its value in relation to operation. As to removal of the pectoralis minor, the speaker had not seen enough cases in which this had been done to know the results. Doctor Peck, however, had felt that this prevented contracture in the axilla and had advocated it very strongly, for that reason.

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